THURSDAY, JANUARY 21, 1915.

THE MANUFACTURE OF DYESTUFFS IN BRITAIN.

A Summary and an Appeal.

THE speech of Lord Moulton in Manchester on December 8, 1914, was a notable event, even in these days of strenuousness and surprise. For although he was careful to disclaim any official sanction of the views he expressed, it was common knowledge that the Government had requisitioned his services in investigating the question of the shortage of dyestuffs, and had based its policy largely on the advice he gave as the outcome of his investigation.

The general outline of the crucial position in which the British textile trades are placed at the present time is well known. At least 1,500,000 operatives are engaged in the various branches of the trade, which has an annual value of 200,000,000*l*. Nearly the whole of this vast industry depends for its commercial success upon the use of dyestuffs, which cost about 2,000,000*l*. per annum, and only about 10 per cent. of the necessary quantity of dyestuff is made in this country. Before the war, between 80 and 90 per cent. of our dye-wares was imported from Germany, and this supply is now entirely cut off. Unless, therefore, immediate steps are taken greatly to increase our national output and the supply from neutral countries (chiefly Switzerland), a catastrophe will very quickly overtake the great textile and associated industries.

The magnitude, gravity, and imminence of the crisis clearly pointed to the necessity for Government action, and a "Chemical Supplies Committee" was appointed to confer with the Board of Trade on the position. This committee included a number of well-known chemists, and manufacturers and users of chemicals and dyestuffs. The investigations of Lord Moulton and of this committee are understood to have formed the basis from which the offer of the Government was developed, but the committee was apparently not responsible for the details of the scheme for the establishment of a large Joint-Stock Dye Manufacturing Company, which was made public on December 22, 1914.

Prior to this, on December 10, 1914, a meeting of large users of dyes was held at the Board of Trade, at which a resolution was unanimously passed welcoming the assistance of the Government in a national effort to increase the British supply of dyes. A small committee, representative only of the users of dyes, was appointed, and elaborated the scheme to which reference has already been made for the formation of a manufacturing company.

An influential committee, appointed by the Society of Dyers and Colourists, has also made exhaustive inquiries on the technical side and has accumulated much valuable information.

It is well known that the difficulties involved in establishing on a permanent basis the manufacture of dyes on a scale adequate to supply our needs are enormous, and that without Government or legislative assistance they might well prove insurmountable; and the action of the Government in proffering such broad-minded and generous support has received, as it deserved, the recognition of all parties.

The German colour industry is probably the most complicated, most highly developed, and most profitable of all her great industries. The capital invested in it is about 12,000,000*l*., and the German exports of dyes and associated products in 1912 were valued at 10,600,000*l*. The organisation, both for production and for marketing and distribution, is wonderfully efficient, and above all the Germans have long realised that in this branch of industry the scientific mind and scientific method must be predominant, not only in the laboratory and in the works, but in the management. The boards of directors of their large works are virtually committees of technical and commercial experts who are in intimate touch with the respective branches of the works of which they have special knowledge. In a word, the trained man of science has in these works come to his own, and a proper recognition of the necessity of this is vital to the development of the British colour industry.

The reasons for the predominance of Germany in this particular industry have been frequently and variously stated, but it is now generally conceded that there is no lack of highly-trained chemists in this country competent to build up a commercially successful enterprise. With regard to other factors, we have, of course, a superabundance of the coal-tar products which form the basis of the manufacture, but the manufacture of certain essential reagents, *e.g.*, fuming sulphuric acid, though already existing, may have to be increased.

Government assistance will be required in regard to the provision of cheap alcohol, and the resources and skill of the chemical engineer will be

heavily drawn upon to provide the essential apparatus. A great number of chemists will be needed to work out the details of known processes, first on the laboratory scale, and later on a bulk basis, and the well-equipped laboratories and staffs of the universities and larger technical institutions might well be pressed into service for much of the preliminary work. Many chemists will also be required for developing new processes and other research work, because of no other industry can it be so truly said that stagnation spells failure.

The great complexity of the manufacture of dyestuffs is not due to the use of a large number of raw materials, the direct products from coal tar being only nine or ten. By chemical treatment these are, however, transformed into 250 to 300 different intermediate products which, in their turn, yield some 1200 chemically distinct dyestuffs. In some processes of manufacture high temperatures and pressures are required; in others the temperature must be reduced, and a large refrigerating plant is an essential feature of a colour works.

Surely, then, it is abundantly evident that the technical expert must be the preponderating element in the dye factory, and that he must have a large share in the management and control. The British custom of entrusting the management of large concerns to financiers, commercial magnates, and "men of affairs" has done much to retard the scientific development of our industries, and the adequate representation of the technical expert on the directorate is vital to the success of the new scheme.

Lord Moulton laid down three propositions with regard to the proposed new British dye manufacturing company. It must be large enough to be able to face severe competition at the end of the war. It must be, and must remain, entirely British, and, it must be co-operative; and all these conditions are fulfilled by the scheme put forward. It is proposed that the share capital shall be 3,000,000*l.*, and the Government offers to supplement this by a loan of 1,500,000*l.* at 4 per cent. and repayable in twenty-five years. The four and a half millions of capital thus proposed is probably ample to establish and develop an industry which would make us independent of imported products.

The proposals with regard to co-operation are that dyers and others associated with the consumption of the products, *e.g.*, spinners, manufacturers, merchants, textile machinists, etc., should take shares in the new company and thus become interested in its success. This is quite sound and receives general acceptance, but certain suggestions in the prospectus with regard to a *pro rata* subscription appear to be unworkable.

The Government reserves the right of appointing two directors of the company, and it is much to be regretted that the opportunity has not been taken of giving a wise lead in regard to the character of the directorate, by stipulating that the scientific technologist should be adequately represented.

Another feature of the scheme propounded by the committee is that certain existing colour works are to be taken over by the new company to form the nucleus of development. The resources of these works are to be extended as rapidly as possible in order to cope with immediate necessities and prevent an actual famine in dye-wares—in fact, large extensions are at the present moment being made.

A point which presents some difficulty in adjustment is the relationship of the new company to existing British dye-producing firms, or such as may be established in the future. It is obviously not desirable to stifle private enterprise by anything in the nature of a monopoly supported by the Government, but the existence of successful German firms which are outside the two great "Interessengemeinschäfte," or rings, indicates that the difficulty is more apparent than real. A somewhat cognate matter is the future relationship of the new company to the Swiss firms which are importing to us during the present crisis.

The various criticisms of the Government scheme which have been offered, refer, not to general principles, but in almost all cases to more or less important details. The general outlines of the scheme—the establishment by co-operation of those specially concerned, of a new company with great resources and financially aided by the Government—has received general approval, and the unprecedented step taken by the Government has been applauded by men of all parties, as meeting an industrial crisis in a bold and statesmanlike manner. In response to this, and in recognition of a national emergency, it is the obvious duty of all who are commercially interested, to deal with the question from the national rather than from the individual point of view. Support of a scheme for the manufacture in Britain of British used dyes is, at its lowest estimate, an essential business insurance, and on a higher plane it is helping forward a movement to free our great textile industry from the danger

of German domination. Apart altogether from the commercial aspect, there is, therefore, a great obligation of patriotism involved. The scheme put forward—possibly as a *ballon d'essai* as regards details—certainly requires modification, but from it can be elaborated a national and co-operative effort which is bound to succeed.

Even to discuss the question of the breakdown of the proposal to make ourselves independent of German products, is almost a triumph for the enemies of our country, and a national humiliation for us. Let us all take as a starting-point of our deliberations that the thing *must be done*, and then the details of how to do it will fall into proper perspective.

Finally it may be pointed out that incidental advantages of enormous national value will accrue as the result of the successful fruition of this dye-ware manufacture scheme. The necessity for dealing with our industries from a national, rather than an individualistic, point of view will be more fully recognised by the Government and by the public. The necessity for the use of scientific method and control of our industries will be strongly emphasised. The claims of patriotism and the value of co-operation in commercial matters will receive fuller consideration, and lastly, the establishment of a powerful company for the manufacture of organic dyestuffs will afford protection to our great industries concerned in the manufacture of inorganic chemicals, an attack on which was beginning to be organised.

Now is our opportunity, and everything is propitious. Patriotism and self-interest are alike clamouring for the establishment of a large dye manufacturing concern, and the Government offers its support. One essential thing may, however, be overlooked—the new company is foredoomed to failure unless a scientific, rather than a purely commercial spirit permeates the management, and an appeal is made to the Government and to the eminent business men forming the committee who have issued the scheme that in its final form it may include a full recognition of this fundamental point.

WALTER M. GARDNER.

ELECTROMAGNETIC WAVES.

Electromagnetic Theory. By O. Heaviside. Vol. iii. Pp. ix + 519. (London: *The Electrician* Printing and Publishing Co., Ltd., n.d.) Price 21*s.* net.

IT is scarcely necessary to recommend to those interested in electromagnetic theory any book or article written by Dr. Oliver Heaviside. Since 1899 the scientific world has had in possession the first and second volumes of his "Electromagnetic Theory"; and these volumes hold a unique place in the literature of the subject. The first volume was reviewed in NATURE of 1894 (see vol. li., p. 171), and the second in 1899 (see vol. lx., p. 589). Now, after fourteen years of waiting, the world is enriched with the third and presumably the last volume containing the author's views upon the later developments of this ever-growing science.

The third volume is marked by all the characteristics of the earlier volumes. There is shown the same powerful grasp of the great principles of Maxwell's theory, the same intuitive intimacy with the hidden features of the electromagnetic field, the same boldness in materialising the mathematical conceptions, the same fearlessness in attacking really difficult problems, inventing new mathematics if necessary, or ingeniously turning to account old results got in different lines of inquiry. Every now and again he runs off into a side alley, at first sight quite away from the natural highway, but out of which he leads us back with some substantial gain, fitting us the better for the strenuous work to come. And we need all our best powers to follow his lead. There is no shirking of difficulty; there is no yielding to authority. Every new fact or hypothesis in electromagnetism must pass through his critical mind, every new theory be looked at carefully and the evidences for and against balanced against each other. The book is indeed the product of a hard-working and ingenious mind, and bears throughout the unmistakable marks of the personality of the author.

The modified quaternion analysis which Dr. Heaviside introduced into the earlier volumes is used with good effect when occasion demands. There is, of course, nothing talismanic in the particular notation which Dr. Heaviside has adopted; and it seems a pity to stir up old controversy by reproducing letters written last century. When the author accuses Tait of viewing the same thing quite differently according as it is clothed in his (Tait's) favourite quaternion garb or in so-called vectorial vestments, he uses a sword with a cutting edge in the hilt. We have simply to change Tait to Heaviside and interchange the words quaternionic and vectorial, and the truth remains. And the curious thing is that all the change which Dr. Heaviside makes in the Hamiltonian notation is to drop the S for scalar and change the sign. Meanwhile more recent vector analysts equally despise Hamilton and Heaviside, and add to the confusion by inventing their own precious notations.

The subject-matter of the present volume is very simply described. It has to do with the

generation and propagation of electromagnetic waves. There are two chapters which are numbered ix. and x. in continuation of the chapters of the earlier volumes. The sections are also numbered in continuation of the sections of vols. i. and ii. The fifty-three sections which constitute chapter ix. were published originally in the *Electrician* during 1900 and 1901, and are grouped under the title of "Waves from Moving Sources." Largely by synthetic methods the author constructs the solutions of various cases, discussing in his own way the fundamental question of the connection between matter and æther. Some interesting remarks are made concerning the investigations of Larmor and Lorentz. The later sections deal with spherical pulses started by a "jerked electron."

Chapter x. with its forty-one sections occupies about three-quarters of the whole book. It is called "Waves in Ether." The first seven sections, reprinted from the *Electrician* (1902) form a group of connected discussions in which a deformable æther is assumed along with a constant velocity of radiation through it. The assumptions are found to be compatible if the inductivity and permittivity of the æther vary as the density. The remaining sections, some of which appeared originally in NATURE, are more of the character of isolated articles, bearing either directly upon electromagnetic theory or upon mathematical and physical problems suggested by its development. For example, there is a long article on the solution of definite integrals by differential transformation, and one nearly as long on the inversion of operations. Still longer is section 534, on the theory of an electric charge in variable motion, probably one of the most important in the whole book. Here, as elsewhere, Dr. Heaviside strongly affirms the truth of Newton's Third Law of Motion, "an impregnable fundamental principle whose neglect sometimes leads to alarming consequences." Why, he asks at the very end of the volume, is this principle to be taken as fundamental? "Because it is always true when proper examination can be made, and is the guide to fresh knowledge. Besides that, the untruth of the principle in practice would lead to chaos."

Dr. Heaviside is also a firm believer in the existence of the æther. "Through this ether all known disturbances are conveyed electromagnetically or gravitationally. If the first way, the speed is finite. If the second way, it may also be finite, perhaps with the same velocity. . . . As the universe is boundless one way, towards the great, so it is equally boundless the other way, towards the small; and important events may arise from what is going on in the inside of atoms, and again, in the inside of electrons. There is no energetic difficulty. Large amounts of energy may be very condensed by reason of great forces at small distances. How the electrons are made has not yet been discovered. From the atom to the electron is a great step, but is not finality."

To the elucidation of the deep problems involved in this confession of scientific faith, Dr. Heaviside has made great and lasting contributions. The strenuously minded student will find him a stimulating guide through the intricacies of the electromagnetic equations. The book is with great fitness dedicated to the memory of George Francis Fitzgerald. C. G. K.

THE ASCENT OF SAP IN PLANTS.

Transpiration and the Ascent of Sap in Plants. (Macmillan's Science Monographs.) By Dr. Henry H. Dixon. Pp. viii+216. (London: Macmillan and Co., Ltd., 1914.) Price 5*s.* net.

PROF. DIXON first became known as an investigator of the problem of the ascent of water in plants by his work in collaboration with Dr. Joly published in the Proceedings of the Royal Society, 1894, and in the Philosophical Transactions, 1895, and from that time forward he has with admirable patience and efficiency continued to work at this difficult question. The appreciation of his position as an authority in this department is shown by his having been most appropriately chosen as a contributor to the "Progressus Rei Botanicæ," and finally as a writer in the present series of science monographs.

When a second edition is called for, it is to be hoped that Dr. Dixon will see his way to giving the references to literature as footnotes instead of at the end of the chapters, an arrangement that seems to us to have no practical advantages. The only other criticism of a general kind that we have to offer is on the relative space given to the two main divisions of the subject. There is but one chapter on the "nature of transpiration," while the remainder, consisting of about 200 pages, deals with the ascent of sap. But there is so much to be said on the latter subject that the author may well feel justified in his comparatively brief treatment of transpiration. There are many interesting points in chapter i., *e.g.*, the discussion on transpiration considered as a form of secretion, and the allied question of transpiration in air saturated with moistures.

Prof. Dixon does not, we think, quite realise the danger of assuming that the stomata are thrown out of action as far as transpiration is concerned by dull light or darkness. But inas-

much as his interesting experiments on transpiration in oxygen, air, CO_2, ether, and chloroform give values differing *inter se* in practically the same way as the evaporation of a surface of water under like conditions, it must be allowed that there is here no error of the above-mentioned kind.

The second chapter is devoted to the discussion of those hypotheses of the ascent of water in trees which depend on the co-operation of living cells in the water-way, views that may be said to begin with Godlewski's theory (1884), which was followed by the cognate hypotheses of Westermaier, Janse, and others. The whole chapter is good reading, but the most interesting part is the description of Dixon's experiments bearing on the effect of killing the sections of the water-way by heat. In this way it has been shown by Janse and Ursprung that the transpiration current is checked and that the leaves above the heated region wither. This fact was used as an argument for the "vital" theories of the ascent of water. But Dr. Dixon shows clearly that by heat, poisonous substances are developed, and that withering occurring above the injured region may undoubtedly be produced by this cause, and therefore that the argument for vital theories loses its validity.

With chapter iv. begins the kernel of the book, namely, the re-statement of the cohesion theory of the ascent of water. The most interesting features of this section are the discussions on the effect of air bubbles in the water conduits, and the evidence in favour of cohesion theory which is derived from a general discussion on the structure of wood.

This is followed in the next chapter by a discussion of the purely physical problem of cohesion. He confirms and extends Berthelot's estimation of the tensile strength of water containing air, a point of great value. He also works out the tensile strength of sap—a necessary precaution—and records the astonishing tensions of about 132 and 207 atmosphere. The sap used in these experiments was ingeniously obtained by centrifuging, a method likely to be useful in other botanical researches.

Having shown how great is the cohesion of the water columns, Dr. Dixon goes on to the other half of the problem—the resistance offered by wood to the passage of sap. He makes it probable that Ewart's estimate of this element in the problem is much too high, and points out (p. 132) "that if Ewart had obtained my results, the difficulty of resistance, which he finds to be fatal to the cohesion theory of the ascent of sap, would not have presented itself to him."

The rest of the book is mainly devoted to the question whether the leaves can develop traction sufficient for raising the sap, a force which he says (p. 139) "must at least be equal to the pressure produced at the base of a column of water which is twice the height of the transpiring tree." The problem in fact comes to be whether the osmotic pressure in the cells of the leaves is sufficiently great to account for the raising of water in very tall trees. One method employed was to expose leaves to compressed air in a closed vessel; in this way it was shown pressures of 26–38 atmospheres must exist in the leaves. Finally he proceeded to ascertain the osmotic pressure in the leaves by determining the freezing point of the cell sap. This was effected by employing a thermocouple in place of the thermometer used in Beckman's method of cryoscopy. In this way Dixon is able to determine the freezing point of small quantities of fluid—a practical point of considerable importance. The osmotic pressure in the leaves deduced by this method are finally shown to be more than sufficient to account for the ascent of water. F. D.

THE SCHUMANN REGION OF THE SPECTRUM.

The Spectroscopy of the Extreme Ultra-Violet. By Dr. T. Lyman. Monographs on Physics. Pp. v+135. (London: Longmans, Green and Co., 1914.) Price 5*s*. net.

THE remote ultra-violet part of the spectrum, first investigated by Victor Schumann and since known as the "Schumann region," has in recent years become of distinct importance in several directions. A knowledge of the vibrations of short wave-lengths is indispensable in the study of spectral series in relation to theories of emission spectra, and it has further been found that photo-electric, photo-chemical, and photo-abiotic processes become much more pronounced in this region. In the present monograph full accounts of the methods and results of observations are given in an interesting and convenient form by Prof. Lyman, who was among the first to take up and extend the work of Schumann. The first part of the book, referring to the ordinary ultra-violet spectrum included between wave-lengths 4000 and 2000, is a valuable introduction to the larger second part in which the Schumann region is dealt with.

As is now well known, the opacity of air, glass, and quartz to the Schumann rays renders it necessary that the entire spectrograph and source of light should be enclosed in a vacuum, and that special materials should be used for the construction of lenses and prisms; specially prepared photographic plates are also necessary. Schumann's

apparatus was a "vacuum spectrograph" having prisms and lenses of fluorite, but Prof. Lyman has employed a concave grating of one metre radius, which is much simpler in adjustment and has the great advantage of permitting the determination of wave-lengths. A full description of this instrument is given, together with many practical details which have contributed to its successful manipulation. The absorption of various gases and materials in the region of short wave-lengths is fully discussed, and the spectra of the various elements which have hitherto been investigated are described in detail. Complete tables of these spectra, and a bibliography of the whole subject, are also included.

It is interesting to note that the author has lately succeeded in photographing the spectrum to wave-length 905, thus extending it as far beyond Schumann's limit as this was beyond the limit reached by Stokes, about wave-length 1850, if counted on the scale of oscillation-frequencies. Further extension by the direct spectroscopic method is beset by many difficulties, but the author does not consider it hopeless to make further attempts to reduce the gap between the shortest Schumann waves and the waves constituting X-rays, which have a wave-length of about one Angström unit. In this gap the relation between "light" and matter undergoes a profound change, and further exploration would doubtless lead to results of great value.

The book is a valuable record of successful work in an important field of research, and will be indispensable to those wishing to undertake investigations in the Schumann region, or having occasion to make use of the available data of observation. It may, however, be confidently recommended to the larger circle of readers who are interested in the progress of physical science.

OUR BOOKSHELF.

The City of Dancing Dervishes and other Sketches and Studies from the Near East. By H. C. Lukach. Pp. xi+257. (London: Macmillan and Co., Ltd., 1914.) Price 7*s.* 6*d.* net.

THIS collection of papers, the work of a careful student of the Nearer East, most of which have already appeared in periodicals, is of value at the present time. The treatment, however, is sketchy, and some of the questions discussed do not easily lend themselves to popular writing. The chapter on the jests of the Turkish humorist, Khoja Nasr-ed Din, scarcely deserved re-publication, being a collection of "chestnuts," unless an attempt could have been made to trace their analogues in Western folklore. An interesting paper, based on personal knowledge, describes an interview with the Chelebi Effendi, the leader of the Dancing Dervishes, a Persian by origin, a scholar and theologian, intimately associated with the Turkish Court, his function being to gird each new Sultan with the historic sword of Osman at the Eyub mosque at Constantinople, a ceremony which no Christian is permitted to witness. The best result to be expected from the sketch of the Sunni and Shiah sects and of the origin and influence of the Caliphate may be to attract the reader to the standard authorities, from Gibbon to the Encyclopædia of Islam.

The net result of the book is to show the weakness of the Turkish Sultans' claim to the Caliphate, which will probably now be transferred to the new Sultan of Egypt, and to illustrate the hopelessness of the prospect of a Jehad or holy war preached from Constantinople. The Allies are quite aware of the weakness of the Turkish position, and one result of the war must be that Islam will be revolutionised, much to their advantage.

The Principles of Irrigation Practice. By Dr. J. A. Widtsoe. Pp. xxv+496. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1914.) Price 7*s.* 6*d.* net

As President of the Utah Agricultural College, Dr. Widtsoe has had almost unique opportunities of learning at first hand the results obtained by irrigation in the dry States of America, and in this book he gives a summary of his own investigations and those of others in neighbouring States. The general importance of the subject becomes manifest when it is realised that about 25 per cent. of the earth's surface receives ten inches or less of rainfall annually and can only be reclaimed by irrigation, while another 30 per cent. receives between ten and twenty inches of rainfall and requires irrigation for all intensive cultivation.

The first few chapters deal with theoretical considerations. The soil is likened to a mass of mineral particles, on which hangs a film of water; calculations are given to show its thickness, and some of its properties are sketched out This view is necessarily only approximately correct, because it is now known that the soil has not this simple constitution, but is essentially a colloidal mass. Many of the theoretical considerations founded on the older and simpler idea therefore require modification. Similar remarks also apply to some of the coefficients and constants applied to the soil moisture: their theoretical interest is not great, although they are very important as guides to the practical man in irrigation practice. The chapters, however, give as good a summary as our present knowledge permits, and they clearly show how necessary it is to overhaul the whole subject in the light of modern conceptions.

By far the greatest part of the book is taken up with an account of the effect of irrigation on the crop and on the land, and illustrations and diagrams are given in profusion. The work is admirably done, and gives one of the best summaries of the subject that we have seen for some time.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Electrical Notation.

THE variety of notations for electrical quantities has become a real difficulty in reading international literature. Up to the end of last century the notation of Maxwell was the standard in Great Britain, and such extensions as became necessary were grafted on it. There is no sign of its dying out among the workers, many of them of fundamental importance, who have been accustomed to employ it—in pure science at any rate.

You direct attention (p. 541) to the conflicting recommendations produced simultaneously by two committees, each carrying authority. As the list which you reproduce on p. 545 claims to have international force, it would be interesting to speculate how many readers could guess what are the quantities proposed to be denoted by the symbols η, f, G, ϵ, X, Z, S, Φ. A German equivalent for f is given as ν, which is usually synonymous with n further up in the table; so that f seems to be a duplicate.

Cambridge, January 15. J. LARMOR.

The Influence of Icebergs on the Temperature of the Sea.

THE part of the "Report on the work carried out by the s.s. *Scotia*, 1913," on the above subject, referred to in NATURE of January 14, will, I fear, be a great disappointment to many after the great promise given by the new line of investigation discovered by Prof. H. T. Barnes, of Montreal University. Prof. Barnes found, by means of a very sensitive registering thermometer, that there was always a rise in temperature of the sea on approaching icebergs, and part of the *Scotia's* work was to check this observation. The *Scotia* was fitted with two sensitive registering thermometers, one to be used for trawling near the surface; the other was placed in a box through which the condenser water for the engine was pumped. Unfortunately, both these instruments soon became defective owing to sea water leaking into them. The one used for surface temperatures was repaired on the voyage, but the other does not seem to have been restored to working condition. The result is that all the temperatures taken with the recording instrument are surface temperatures taken at a depth of 2 ft.

The following is the conclusion come to by the observers on the *Scotia*. "An inspection of the records . . . leads to the conclusion that the temperature of the sea near its surface does not furnish a certain method of detecting the presence of an iceberg in the regions over which the *Scotia* made her voyages." Now Prof. Barnes's conclusion was not arrived at from temperatures taken near the surface, but at some depth. His records of the rising temperature on approaching icebergs were made with his first ship, in which the thermometer was placed at a depth of 5 ft., but better results were obtained by his second ship, in which it was placed at a depth of 16 to 18 ft.

In justification of their conclusion that their surface temperatures ought to give results similar to the deeper ones, the observers on the *Scotia* seem to have accepted Prof. Barnes's explanation of the cause of the rise in temperature near the berg. Prof. Barnes says all the water from the melting ice is carried downwards, and that this downward current is supplied by a surface current flowing towards the berg, and that this surface current, in some way not explained, retains all the solar radiation, which he says usually penetrates deeper, but is, he says, prevented by the water being in motion. If that explanation be correct, then the *Scotia's* observers would be quite right in supposing that the rising temperature would be more manifest at the surface than at some depth. Though the *Scotia's* observers accepted Prof. Barnes's explanation of the heating of the water, they do not seem to be satisfied with it, as they say: "This explanation is difficult and seems complicated."

Prof. Barnes's explanation is founded on the supposition that all the water of the melted ice is carried downwards. Dr. Otto Pettersson, on the other hand, says that only the water of the ice melted some distance below the surface is carried downwards, while that melted near the surface flows away from the berg on the surface. In a previous letter (NATURE, January 9, 1913) I showed by two methods of experimenting that all the water of the melted ice comes to the surface. I think it is generally admitted that the salinity of the sea is, as a rule, lower in the vicinity of melting ice than at a distance from it. If so, where does the fresh water come from if not from the melted ice? Outside the rising current of diluted sea-water next the ice there is a descending radiation-cooled current of sea-water drawn from a distance and flowing underneath the ice-cooled water on the surface. This downward current is accepted by Prof. Barnes and Dr. Pettersson, though Prof. Barnes does not admit the existence of the cold-surface current. Accepting the existence of these currents in the water surrounding icebergs, the following explanation was offered in NATURE (March 16, 1913) of the rising temperature observed on approaching icebergs. The surface water at a distance from a berg has a higher temperature than the water immediately underneath it. That is, outside the influence of the berg the temperature decreases with the depth, so that when the surface water is submerged by the cold-surface current, it is sunk to some depth beneath the surface, the result of this being that a thermometer sunk to a depth of, say, 16 ft. when at a distance from the berg registers a lower temperature than if placed in the surface water; but if the deeply submerged thermometer be moved into the water near the berg, it will now register a higher temperature than it did at a distance from it, because it will now be in the submerged-surface water, the temperature of which will probably have fallen to some extent in its passage under the cold-surface water. The effect of the movement of the ship towards the berg is virtually the same as raising the thermometer towards the surface when the ship is outside the influence of the berg. In the letter referred to I suggested the use of two thermometers, one near the surface, the other at some depth, and registering together, when an inversion of the temperature would indicate the approach to ice, if the explanation be correct. If this inversion of temperature really does exist, it might be detected by the ordinary tilting thermometers, one in the water near the surface, and others at depths down to three or four fathoms, as the difference that might be looked for from Prof. Barnes's thermograms amounts at times to a degree or more Centigrade, an amount easily detected by means of thermometers of that kind.

It is a great misfortune that the thermometer in the condensation water of the *Scotia* could not be repaired for the investigation. The depth at which

the inlet of the condensation water was placed is not stated in the report, but from the size of the vessel it could not be very deep, and the best results could scarcely be expected from it, and for the same reason it would be of no use save in fine weather, owing to the rolling of the vessel constantly changing the level from which the water was drawn. Still, under calm conditions, it might have been deep enough to touch in some cases Prof. Barnes's rising temperature.

Prof. Barnes's results are so consistent and definite that they carry conviction, and one can scarcely imagine that the observations taken when sailing towards, and from, an iceberg in many different directions, which enabled him to draw the isotherms all round the berg as given in his report and reproduced in your issue of December 12, 1912, could be the result of chance, and not of something which had a real physical existence. It is possible that the conditions there represented may be rare, as they seem to indicate that the berg and the water had travelled together for a long time. It seems probable that in many cases the distribution of the isotherms will not be so regular owing to the berg and the water moving at different rates and in different directions. One conclusion we may, however, come to from the *Scotia's* observations which is that the explanation of the rising temperature on approaching icebergs is not due to radiation as supposed, as the registering thermometer on the *Scotia*, though not as sensitive as that used by Prof. Barnes, was yet easily capable of detecting changes such as those indicated by Prof. Barnes's thermograms. It is to be hoped that the subject will be further investigated after the war is ended.

JOHN AITKEN.

Ardenlea, Falkirk, January 4.

The Longevity of Seeds.

IN the note in NATURE of January 7 (p. 515) upon Mr. Shull's paper in the *Plant World*, referring to the longevity of seeds, it is stated that this "is a subject on which specific information is always desirable." The following, therefore, may at least contribute suggestion.

In 1862, my father, at a cost of 4000*l.*, caused Dowalton Loch, the largest sheet of water in Wigtownshire, to be drained. The operation attracted considerable attention at the time, owing to the subsequent exploration of a number of "crannogs," or lake dwellings of the fascine type which were laid bare. The bottom of the lake, about 200 acres in extent, was for the most part covered with deep mud and peat; but across the centre of it lay a ridge of broken rock, now a dense jungle of dog willow (*Salix caprea*), whereof the seeds were no doubt wind blown.

Six years ago I was clambering among these rocks, and, coming upon an open space in the thicket, found to my surprise that the ground, to the extent of nearly an acre, was thickly covered among the stones with a carpet of *Pyrola minor*. Nowhere, except in Norway, have I seen this pretty plant in such profusion.

Now, although I have given fairly close scrutiny to the phanerogamous flora of this country, I have not found *P. minor* within its bounds, though for forty years I have known of a colony of it in the neighbouring county of Kirkcudbright, about five and twenty miles in a straight line from Dowalton Loch. *P. rotundifolia* also grows on the banks of the Cree about twenty miles distant.

No doubt *P. minor* once abounded in Wigtownshire, but it has disappeared under the plough, though it may linger still in the remote moorland. Dowalton Loch lies in the heart of an arable, closely cultivated district. Whence, then, did the minute seeds come which have produced this surprising crop? Have they lain dormant under the waters of the loch since the days of the lake-dwellers, or—a more moderate guess—since the days when the primeval forest bordering the lake was cleared away and the land broken up for tillage?

I shall be happy to receive a visit from anyone who may desire to verify for himself the topography of the district in connection with this isolated mass of Pyrola.

HERBERT MAXWELL.

Monreith, January 11.

S. T. Coleridge and the Immortality of the Protozoa.

THAT Weismann's aphorism regarding the "immortality" of the Protozoa had been uttered by others before him is not unknown; and Mr. Clifford Dobell in a recent paper ascribes to Ehrenberg the first expression of the idea. Ehrenberg's book was published in 1838; but Coleridge had said the same thing many years before in his "Biographia Literaria," published in 1817 and written a couple of years earlier. In a footnote to chap. iv. (on Wordsworth's "Lyrical Ballads") he says: "There is a sort of minim immortal among the *animalcula infusoria*, which has not naturally either birth or death, absolute beginning or absolute end: for at a certain period a small point appears on its back, which deepens and lengthens till the creature divides into two, and the same process re-commences in each of the halves now become integral." No statement of the case could well be plainer or more precise than this. I wonder whether Coleridge was indeed the first to make it; or whether some one of the eighteenth-century naturalists had already drawn the inference—not, after all, a very profound one—that a creature which multiplies by simple fission "has not naturally either birth or death," and may be called "immortal."

D'ARCY W. THOMPSON.

The Cause of Streaks upon Lath-and-Plaster Walls.

FOR some time past I have been observing the streaks which occur upon lath-and-plaster walls. I have made a survey of the literature and find no adequate treatment of the phenomenon. For that reason I take the liberty of submitting to you the results of my observations in the hope that you may find them worthy of publication. The results of my observations are as follows:—

(1) The striations are accumulations of dust upon the surface of the plaster. They may be wiped off with a cloth.

(2) The phenomenon occurs only on warmer surfaces of walls which are exposed on the other side to out-of-doors or to colder rooms.

(3) The steeper the temperature gradient through the wall, the more pronounced is the phenomenon.

(4) The light streaks, the spaces comparatively free from dust, occur over laths and joists, the dark streaks over the spaces between them.

Poynting and Thomson ("Text-book of Physics: Heat," p. 152) suggest "that the phenomenon is a probable illustration of 'radiometer action.'" The areas of plaster backed up by wood are probably warmer than those areas not so protected. From the supposedly warmer area an approaching dust particle is repelled by a more vigorous molecular bombardment than it encounters upon approaching the supposedly colder area.

I was led to inquire whether this explanation is a complete one upon observing what appears to be a related phenomenon. In a room rather free from dust but quite damp, the areas of plaster which ordinarily would be streaked with dust were quite clean, but were much discoloured by water. This observation

raises the question as to whether condensed water vapour may not be the trap which catches the dust.

I contemplate carrying out a series of experiments to answer the following questions:—

(1) Under given conditions what difference of temperature exists between a plaster area backed up by lath, and an adjacent area not so protected?

(2) What part does the presence of water vapour in the air play in the phenomenon?

(3) Can a "reversal" of the phenomenon be produced?

THOMAS D. COPE.

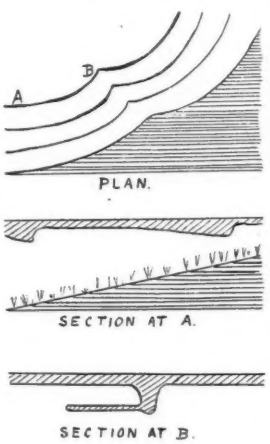
University of Pennsylvania, Philadelphia, December 18, 1914.

Curious Forms of Ice.

ON December 30, 1914, when a heavy rainfall had been followed by a night frost, a layer of prismatic ice was seen immediately below the surface of the heaps of loose clay, in shallow workings in clay-with-flints at the south-west end of Walton Heath, Surrey. The workings are near the crest of the North Downs, at an elevation of about 600 ft. The ice varied from ½ to 1¼ in. in thickness, and resembled the form of calcite known as "beef," but even in the most compact portions the prisms were not in close contact with one another. When observed, about midday, the ice was melting, and the sides of some of the heaps were strewn with isolated prismatic and acicular crystals of ice.

This prismatic layer of ice is similar to the ice pillars described in NATURE (vol. lxxiii., 1906, pp. 464, 485, and 534), and analogous to the masses of fibrous ice connected with lumps of chalk, recorded in NATURE (vol. lxxxviii., 1912, pp. 484 and 517).

On the same occasion, shallow pools of rain-water on Walton Heath and Headley Heath were seen to be covered with thin ice, which showed a series of concentric markings parallel to the margin. These markings were formed by ridges on the lower surface of the ice, presenting an abrupt face toward the margin and a gentle slope toward deep water. The ice in the ridges contained air bubbles. The ridges were about 4 in. apart, and in some places as many as seven in number. At points where the direction of a ridge changed, as at B in the figure, a tongue of ice projected downward and sometimes supported horizontal rods of ice half an inch below the surface.



These projections may be analogous to the "bulb formation" referred to by writers in NATURE (vol. lxxxviii., 1912, pp. 414 and 492, and vol. lxxxix., 1912, p. 34). The ridges differ in cross section and direction from those described in NATURE (vol. xc., 1912, p. 411). The pools did not show signs of loss of water by percolation. At first sight I regarded the ridges as earlier shore lines, marking successive extensions of the pools as water flowed into them, but the parallelism and equal spacing of the ridges are perhaps against this view. They may possibly be due to ripples.

G. M. DAVIES.

Birkbeck College, London, January 12.

The Fireball of December 31, 1914.

I AM writing to tell you that I also observed the fine meteor described in NATURE of January 7 (p. 517) as having been seen at Bexley Heath on December 31 at about 11.15 p.m. I saw it from my window, facing the west, and I cannot better your description of it as "a fireball, much brighter than Venus."

Its course was from north to south, rather low down, and the sky at the time was clear above, but misty below. The meteor disappeared without leaving a luminous track behind, and seemed to dip into the mist.

I did not notice what stars it passed near, as the moon was shining; possibly there were not many just then distinctly visible.

FRANCES M. HARVEY.

15 Purland Chase, Ross, Herefordshire.

THE PHILADELPHIA MEETING OF THE AMERICAN ASSOCIATION.

THE sixty-sixth meeting of the American Association for the Advancement of Science was held at Philadelphia, Pa, on December 28, 1914—January 2, or, as it is termed, during the Convocation Week, 1914–15, under the presidency of Dr. Charles W. Eliot, President Emeritus of Harvard University. The Section on Education of the A.A.A.S. is a comparatively new one, and this was the first meeting at which a member of this section has been president of the Association.

The meetings were, almost without exception, held in the commodious buildings of the University of Pennsylvania; the only exceptions being the meetings of Section E of the Geological Society of America and the Palæontological Society of America, which were held at the Academy of Natural Sciences in the central part of the city.

At the opening session, December 28, 1914, the meeting was opened by the retiring president, Prof. E. B. Wilson, of Columbia University, who introduced president-elect Eliot. Addresses of welcome were given by Dr. E. F. Smith, Provost of the University of Pennsylvania, by Dr. W. W. Keen, President of the American Philosophical Society, by Dr. S. G. Dixon, President of the Academy of Natural Sciences, and by Mr. J. M. Dodge, representing the Franklin Institute.

Dr. Eliot replied to these addresses, and the retiring president, Dr. Wilson, then delivered his address on the subject "Some Aspects of Progress in Modern Zoology," which is printed elsewhere in this issue of NATURE.

After the adjournment of the meeting, the provost of the University and Mrs. Smith received the association and its affiliated societies in the University Museum.

The meeting was a very large one, possibly the largest in the history of the association. Registration figures indicate that there must have been more than two thousand scientific men and women in attendance. The number of affiliated societies meeting at the same time and place was also unusually large. It included the following societies:—

Society of American Bacteriologists, Entomological Society of America, American Association of Economic

Entomologists, Botanical Society of America, American Phytopathological Society, American Psychological Association, Society of American Zoologists, American Society of Naturalists, American Microscopical Society, American Physical Society, Geological Society of America, Palæontological Society of America, American Folk-Lore Society, American Fern Society, Sullivant Moss Society, American Nature-Study Society, School Garden Association of America, American Alpine Club, American Anthropological Association, Southern Society for Philosophy and Psychology, Society for Horticultural Science, American Federation of Teachers of the Mathematical and the Natural Sciences, Society of Sigma Xi.

The meeting as a whole emphasised more than ever the importance of symposia for broad topics which bring together men of different sections. A number of these were held during the week, as follows:—

Section B and the American Physical Society, on the subject, "On the Use of Dimensional Equations."

Botanical Society of America and the American Phytopathological Society, on the subject, "Genetic Relationship of Organisms."

Section of Agriculture, "The Field of Rural Economics."

Section F, the American Society of Zoologists, and the American Society of Naturalists, "The Value of Zoology to Humanity."

Society of American Bacteriologists and Section K, on the subject of ventilation.

Sections C and K and the Society of American Bacteriologists, on the subject, "The Life of Lower Organisms in Relation to Man's Welfare."

There were two especially notable incidents of the meeting. The first of these was the first large meeting of the newly-established Committee of One Hundred on Scientific Research, of which Prof. E. C. Pickering, of the Harvard College Observatory, is chairman, and Prof. J. McKeen Cattell, of Columbia University, the secretary. Reports were received from a number of sub-committees, other sub-committees were established, and the work of the committee as a whole was systematised in order to cover the whole field of scientific research in America with the view of the ultimate ascertaining of its needs. The listing and classification of research funds, the needs of research students, the co-ordination of research among educational institutions, private endowments and industrial research, and a number of other topics will be taken up by this committee.

The second notable event of the meeting was the first session of the newly-established Section of Agriculture (Section M). This opening meeting was presided over by the president of the association, Dr. Eliot. The vice-president, Dr. L. H. Bailey, formerly Director of the College of Agriculture of Cornell University, gave his address on the subject: "The Place of Research and of Publicity in the Forthcoming Country Life Development." The symposium which followed consisted of the following addresses: "Rural Economics from the Standpoint of the Farmer," by Hon. Carl Vrooman, Assistant Secretary of Agriculture; "Credit and Agriculture," by Prof. G. N. Lauman, of Cornell University; "Marketing and Distribution Problems," by C. J. Brand, Chief of the Office of Markets, U.S. Department of Agriculture; and "Distinction between Efficiency in Production and Efficiency in Bargaining," by Prof. T. N. Carver, of Harvard University.

The following addresses of the presidents of sections were delivered during the week:—

(*a*) F. Schlesinger, "The Object of Astronomical and Mathematical Research"; (*b*) A. D. Cole, "Recent Evidence for the Existence of the Nucleus Atom"; (*c*) C. S. Alsberg, "Theories of Fermentation"; (*d*) O. P. Hood, "Safety Engineering"; (*e*) J. S. Diller, "The Relief of Our Pacific Coast"; (*f*) A. G. Mayer, "The Research Work of the Tortugas Laboratory of the Carnegie Institution at Washington"; (*g*) H. C. Cowles, "The Economic Trend of Botany"; (*h*) W. B. Pillsbury, "The Function and Test of Definition and Method in Psychology"; (*i*) J. G. Wall, "Social and Economic Value of Technological Museums"; (*k*) T. Hough, "The Classification of Nervous Reactions"; (*l*) P. P. Claxton, "The American Rural School"; (*m*) L. H. Bailey, "A Place of Research and of Publicity in the Forthcoming Country Life Development."

Following the example of the British Association for the Advancement of Science, two public evening lectures complimentary to the citizens of Philadelphia and vicinity were given. Dr. D. C. Miller, of the Case School of Applied Science, lectured on Tuesday evening, December 29, on "The Science of Musical Sounds," illustrating his lecture by a large number of striking experiments. The second was given on Wednesday evening by By Dr. W. H. Nichols, of the General Chemical Company, on "The War and Chemical Industry." These lectures were rather largely attended, but the American Association has not as yet succeeded in making these lectures as important, viewed as social functions, as has the British Association.

No strikingly important matters of business were considered by the council. A few small research grants were made, and the assistance of the association was continued to the Concilium Bibliographicum Zoologicum of Zurich. It was decided to hold a summer meeting in 1915 at San Francisco under the auspices and management of the Pacific Coast Division of the American Association, the dates to be August 2 to 7. For the place of the next Convocation Week meeting (December 27, 1915, to January 1, 1916), Columbus, Ohio, was chosen. It will be remembered that the association had virtually accepted an invitation from the University and City of Toronto, Canada, for this last-named meeting, but on account of conditions arising from the war, Toronto begged to be allowed to postpone this meeting to some future and more favourable date.

At the close of the meeting the following officers were elected for the coming year:—

President: Prof. W. W. Campbell, Lick Observatory, University of California.

Presidents of Sections: A, *Mathematics and Astronomy*, Prof. A. O. Leuschner, University of California; B, *Physics*, Prof. Frederick Slate, University of California; C, *Chemistry*, Prof. W. McPherson, Ohio State University; D, *Engineering*, Mr. Bion J. Arnold, of Chicago; E, *Geology and Geography*, Prof.

C. S. Prosser, Ohio State University; F, *Zoology*, Prof. V. L. Kellogg, Stanford University; G, *Botany*, Prof. W. A. Setchell, University of California; H, *Anthropology and Psychology*, Prof. G. M. Stratton, University of California; I, *Social and Economic Science*, Dr. Geo. F. Kunz, of New York; K, *Physiology and Experimental Medicine*, Prof. F. P. Gay, University of California; L, *Education*, Prof. E. P. Cubberley, Stanford University; M, *Agriculture*, Prof. Eugene Davenport, University of Illinois.

Permanent Secretary: Dr. L. O. Howard, Smithsonian Institution, re-elected for a five-year period from August 20, 1915.

General Secretary: Dr. Henry Skinner, Academy of Natural Sciences. Philadelphia, Pa.

Secretary of the Council: Prof. W. E. Henderson, Ohio State University.

Secretaries of the Sections: A, Forest R. Moulton, University of Chicago, Chicago, Ill.; B, W. J. Humphreys, U.S. Weather Bureau, Washington, D.C.; C, J. Johnston Geophysical Laboratory, Carnegie Institution of Washington, Washington, D.C.; D, A. H. Blanchard, Columbia University, New York; E, G. F. Kay, State University of Iowa, Iowa City, Iowa; F, H. V. Neal, Tufts College, Mass; G, W. J. V. Osterhout, Harvard University, Cambridge, Mass.; H, G. G. MacCurdy, Yale University, New Haven, Conn.; I, S. C. Loomis, 69 Church Street, New Haven Conn.; K, C. E. A. Winslow; L, S. A. Courtis, Liggett School, Detroit, Mich.; M, E. W. Allen, Office of Experiment Stations U.S. Department of Agriculture, Washington, D.C.

Treasurer: R. S. Woodward, Carnegie Institution of Washington, Washington, D.C.

Assistant Secretary: F. S. Hazard, Office of the A.A.A.S., Smithsonian Institution, Washington, D.C.

THE EARTHQUAKE IN CENTRAL ITALY.

THE earthquake of January 13 was by no means one of the first order of magnitude, but it was the most destructive of which we possess any record. In Avezzano, which formerly contained 11,000 inhabitants, the death-rate amounts to 90 per cent., while it rises still higher in some of the adjoining villages, in Cese to 94 per cent., and in Lapelle to 97 per cent. Before this, the highest known death-rate was 81 per cent. at Avendita during the Norcian earthquake of 1703. There can be little doubt that the disastrous character of this earthquake was as usual due to the faulty construction of the houses, which consisted of stones with little or no binding of cement. Partly, also, it was due to the comparative immunity of the central district from great earthquakes in the past, which has allowed such buildings to survive.

Few details of scientific value have as yet reached this country. The earthquake occurred at 7.53 a.m. (or 6.53, Greenwich mean time). At Rome, it lasted from 15 to 20 seconds. Near the epicentre, there was one shock of great violence, followed by three others. In other neighbouring places, two prolonged shocks were felt. The principal epicentre was no doubt close to Avezzano, probably within five miles of that town. It was in this district that the high death-rates occurred. There was apparently, however, a secondary epicentre including Sora, where 500 persons lost their lives, and Isola Liri; and it is possible that the double shock noticed at some places was due to impulses in two corresponding foci, about twenty or twenty-five miles apart. The area of perceptible damage to buildings extends almost across the peninsula, from Rome on the west to Chieti on the east, these places being 110 miles apart. Towards the north, the shock was felt at Ancona, Perugia, and Grosseto, and, towards the south, at Naples and Potenza; that is, over an area roughly 300 miles long, 240 miles wide, and containing about 56,000 square miles. The shock was recorded at many distant observatories, including those in this country and at Washington. The after-shocks must have been very numerous in the epicentral area. More than 120 were registered at Rome during the first two days, all of them slight, with the exception of one at 8.14 a.m. on January 14.

Earthquakes are neither frequent nor severe in the district chiefly affected. Dr. Baratta, in his "I terremoti d'Italia," defines in it two distinct seismic zones, one including Sora and Isola Liri, the other, less important in the past, extending from Avezzano to Anticoli. To the former zone belong the strong earthquakes of August 19, 1777, and May 9, 1891; and, to the latter, the earthquake of April 10, 1885. The recent shock must have been far stronger than any of these earthquakes, and, as pointed out above, it seems to have consisted of almost simultaneous impulses in both the Avezzano and Sora centres.

C. DAVISON.

VICE-ADMIRAL SIR GEORGE NARES, K.C.B., F.R.S.

BORN at Aberdeen in 1831, G. S. Nares entered the Navy on board H.M.S. *Canopus*, an old battleship captured from the French, in 1845, and was transferred to the *Havannah*, a frigate for service in the Pacific, in 1847. He passed his examination for lieutenant in 1851, and, coming home shortly afterwards, was appointed to the *Resolute*, and sent to the Arctic in the expedition under Captain Sir E. Belcher in search of the Franklin Expedition. His service up to the time he was a lieutenant was entirely in sailing vessels, the motive power of which was the wind applied to the propulsion of vessels by masts, yards, and sails, and this early training made him a thorough master of managing vessels in all circumstances of wind and weather, and although during his service after returning from the Arctic in 1854 he was employed in vessels that were furnished with auxiliary steam power, he was always pleased when he could navigate his vessel under sail alone. One instance of this may be given. When at Malta in the *Newport* in 1869 the chief engineer of that vessel, who was anxious not to go to sea on the day named because he wanted to attend some function on shore with his wife, asked to be given forty-eight hours to take off the cylinder covers, Captain Nares, as he then was, replied: "By all means." The chief engineer was jubilant,

but on the day originally named, after the usual morning muster by division, the order was given "Hands make sail," and the ship sailed out of the harbour, much to the chagrin of the engineer staff. This was a good lesson given with tact and judgment.

During his service in the *Resolute* he took part in the sledge journeys in search of any remains of Franklin. It is not generally known that Arctic sledging was introduced in order to search all the coasts which could not be reached by the vessels for any token of the Franklin Expedition. The ice near the coast is, as a rule, comparatively smooth, consisting of new ice found on the surface between the grounded bergs and the shore line, and this ice is less difficult to travel over than the hummocky ice found in areas off the shore where floes get piled up one on the other from various causes, consequently the sledge parties were able to cover long tracts and to delineate the coast line of numerous islands and straits.

Returning from the Arctic in 1854 he was promoted to lieutenant on October 21, and was sent to one of the armour-plated bombs, constructed specially for the war, 1854–6, for service in the Mediterranean.

From the Mediterranean Nares was transferred to the training-ship for naval cadets, then recently established (1) in the *Illustrious*, and (2) in the *Britannia*, and whilst so serving compiled "The Naval Cadet's Guide and Seaman's Companion." Promoted to commander at the end of 1862 he served in the *Boscawen*, another training-ship, and was then sent to a paddle-wheel vessel, the *Salamander*, engaged in keeping open communication with a party of marines established at Cape York. In his voyages backwards and forwards between Sydney and Cape York he did some useful surveying work and on his return to England in 1867 was selected for the command of the *Newport*, a vessel commissioned for surveying service in the Mediterranean. The opening of the Suez Canal in 1869 necessitated a survey of the Gulf of Suez, and the *Newport* was selected for this service, and was engaged in it during the winter of 1870–71, but in May, 1871, she was sent to England, and her officers and crew turned over to the *Sheerwater*, which vessel, under Nares, proceeded to the Gulf of Suez in the autumn of 1871, and completed the survey from Suez to Koseir by April, 1872.

On the voyage out the *Sheerwater* was instructed to investigate the Gibraltar Strait current, and Dr. W. B. Carpenter embarked on board to assist in that investigation on behalf of the Royal Society. The work was so well done as to mark out Nares for other scientific work, and when, early in 1872, the Admiralty decided to commission a vessel for exploration of the oceanic basins of the world, Nares was chosen to command the ship, and was ordered home to prepare the *Challenger* for her voyage. Leaving England in December, 1872, the *Challenger* executed a series of sections across the Atlantic, and it was then that the system of sections showing the temperature of the ocean from the surface to the bottom was first introduced. Before that time the temperatures were merely plotted in curves. This system of sections gradually revealed the fact that over certain areas the temperature at the bottom remained the same, but that in other areas, adjacent to the first area, the bottom temperature differed, although remaining constant over another considerable space. From this fact it seemed likely that in areas where at equal depths the temperature at the bottom differed in areas adjacent to each other, the difference was caused by a submarine ridge which prevented free circulation. Thus it was known that whilst the Mediterranean had a uniform temperature of from 55° to 56° below a depth of 100 fathoms, the water of the Atlantic adjacent to the Mediterranean decreased in temperature gradually to 36°. The soundings in Gibraltar Strait, just outside the entrance between Cape Spartel and the Spanish coast, revealed the existence of a submarine ridge, and it was then considered probable that in all areas differing much in temperature at equal depths the difference could only be accounted for by the existence of submarine ridges.

The *Challenger* reached the Cape of Good Hope in November, 1873, and in December left for Kerguelen Island to examine a suitable spot for observing the transit of Venus in 1874. This necessitated a triangulation of Kerguelen and a determination of its position. Three weeks were occupied in the work, and records were deposited in cairns to inform the transit of Venus party of the spots considered suitable for the observations. Leaving Kerguelen at the end of January, the *Challenger* then proceeded to the southward as far as the Antarctic Circle to investigate temperatures and depths, and during that cruise, all on board had an opportunity of appreciating the skill of Captain Nares in handling his vessel amongst the icebergs. Gales and snowstorms were not infrequent, and Captain Nares, after consideration, adopted the plan of keeping close to a berg under steam, during night, or in mist or snowstorms, and thus preventing the vessel drifting or sailing into danger. Arriving in Melbourne in March, 1874, and at Sydney in April, the ship was docked and re-fitted, and it was curious to observe how the copper on the bottom was quite corrugated from the strains encountered during the southern voyage. From Sydney the *Challenger* took other oceanic sections across the southern part of the Western Pacific, from Sydney to Wellington, N.Z., from Wellington to the Fiji Islands, and from the Fiji Islands to Raine Island, Australia. From Raine Island the vessel proceeded through the Arafura Sea, the Banda Sea, the Sulu Sea, and the China Sea to Hong Kong, at which port she arrived in November, 1874. On this voyage it was again noticed that the area of some parts of the Sulu Sea differed greatly in temperature at the bottom from the adjacent seas.

At Hong Kong Captain Nares was recalled to England to take command of an expedition about to be organised for Arctic research.

That expedition consisted of two vessels, the *Alert* and *Discovery*, and its primary object was to reach, if possible, the North Pole. Leaving England in the summer of 1875, the vessels proceeded through Davis Strait to Smith Sound, where a secure harbour was found in which to moor the *Discovery*, to form a base of retreat, whilst the *Alert* pushed northward as far as was possible. The ice in the northern part of Smith Sound presented unexpected obstacles, and subsequent observations showed that the polar basin northward of Smith Sound produced masses of icebergs and floes which, being drifted against the coast, were piled one on the top of the other and closed all navigation excepting between the coast and the ice grounded near it. Here, again, the skill of Captain Nares guided the vessel into a fairly secure position between the coast and the grounded ice, a position which it would have been unsafe to take excepting for the *Discovery* left in a secure harbour as a base to fall back on. The winter of 1875–6 was spent in organising sledge parties, one of which, under Commander Markham, was to get as far northwards as possible, one under Lieutenant Pelham Aldrich was to proceed along the coast line in a north-westerly direction, and the third, under Lieutenant Beaumont, was to cross Smith Sound and proceed northward along the Greenland coast. The expeditions along the coast line were successful, as there the ice offered comparatively little obstruction to sledge work, but the rough, hummocky ice encountered by the party under Commander Markham proved to be of such a nature that progress to the northward was very slow and difficult, and the hardships which his party underwent can scarcely be exaggerated.

The sledge parties returning to the vessels towards the end of the summer, Captain Nares decided that it was useless trying to reach the pole from Smith's Sound, and proceeded homewards. The manner in which the *Alert* was extricated from her perilous position and brought safely to England with the *Discovery* was a feat of seamanship any man might be proud of.

After his return from the Arctic Captain Nares was made K.C.B., in recognition of his services, and in 1878 was again given command of the *Alert* to prosecute surveying work in Magellan Strait, but was recalled from that ship in 1879 to act as Marine Adviser to the Board of Trade. This appointment he held for about twenty years. During his retirement, like many another sailor, he took up gardening and was very successful in growing roses.

He died on January 15 and was buried at Long Ditton Church on January 19. The funeral was attended by Captain J. F. Parry, R.N., the hydrographer, who represented the Admiralty, and by several naval officers, most of whom received their first instruction in seamanship from him on board H.M.S. *Britannia*, and many of whom were associated with him in his Arctic Expedition or in the *Challenger* exploring expeditions.

NOTES.

THE Executive Committee of the proposed Meteorological Conference at Edinburgh has handed over to the Scottish Meteorological Society the balance of the funds subscribed for the expenses of the meeting with the hope that when the opportunity once more arises the society will take the initiative in carrying the project into execution. It has been decided that the committees in London and Edinburgh shall be kept in being.

WE learn from *Science* that Prof. J. H. Pettit, professor of soil fertility in the college of agriculture and chief of soil fertility in the experiment station of the University of Illinois, died on December 30 at Pasadena, California; and that Prof. S. B. Christy, professor of mining and metallurgy in the University of California and dean of the college of mining, died in Berkeley, California, on November 30, 1914, at the age of sixty-one years.

PROF. GEORGE FORBES, who has been entrusted by Lady Gill with the duty of preparing a memoir of her late husband, asks us to announce that he would be glad to be favoured with any letters which have been preserved by Sir David Gill's numerous correspondents; and would greatly appreciate any notes—narrative, historical, appreciative, or anecdotal—relating to Sir David's life and personality. All original letters or other documents will be carefully preserved, and returned to the senders at as early a date as possible. Such communications should be addressed to Prof. Forbes at 11 Little College Street, Westminster.

OWING to the war, the fifth International Congress of Philosophy, arranged to be held in London next September, has been abandoned. The General Organising Committee has expressed an earnest hope that the confederacy of the entire philosophical world, which has subsisted since the inauguration of the series of congresses in 1900, and seemed to have attained the rank of a permanent institution, will not be set aside for a longer time than outward circumstances render absolutely imperative. The committee has pledged itself as soon as possible after peace is restored to promote the continuance of this international bond, either by renewing the invitation to meet in this country or by obtaining an invitation from a neutral country.

A REUTER message from New York states that at a dinner given on January 14 at the Aero Club of America, Government officials announced a plan of the Post Office Department to introduce into the postal service 2000 airmen, who would carry sacks of first-class mails. The routes have already been selected by the Department, and it is hoped that the Bill authorising this scheme of aerial transportation of mails will pass next Congress. It may be recalled that, with the sanction of the Postmaster-General, an aerial postal service, for the idea and organisation of which Mr. D. Lewis Poole was chiefly responsible, was carried out successfully between Hendon and Windsor on September 9, 1911, that is, in Coronation year. A sack of letters was conveyed between these

two places in thirteen minutes, and the experiment created great interest at the time. It may be some years before a regular aerial service is established for the transportation of mails, but the report from New York suggests that we are getting within measurable distance of it.

THE *Chemist and Druggist* announces the death on December 28, 1914, at seventy-three years of age, of Prof. Karl Liebermann, professor of chemistry in the Technical High School, Charlottenburg, Berlin.

THE death of Mr. J. S. Harding on January 11, in his seventy-sixth year, has deprived science of a life-long meteorologist. He had been connected with the Meteorological Office since its establishment in 1854, and was private secretary to Admiral FitzRoy—the meteorological pioneer. He retired in 1906, after a service of more than half a century, leaving behind him an abiding memory, having secured the hearty appreciation of the committee and council of the office and the sincere friendship of his colleagues. All who knew Mr. Harding have reason to remember his ever-courteous personality and willingness to help inquiry into meteorological literature in any direction. He had been a member and fellow of the Royal Meteorological Society since 1866, and had contributed valuable work to the researches of the society. He had mastered the chief European languages—a notable asset for the study of international meteorology—and was an esteemed contributor to the columns of NATURE to the very week of his passing into silence.

DR. DE FILIPPI has reported to the Royal Geographical Society at some length upon the work of his expedition in northern Kashmir. Two parties, led respectively by himself and by Major Wood, have gone far to establish knowledge of the topography of the Remo glacier basin and the watershed between it and the Karakoram pass. Their researches appear to necessitate the substantial modification of existing maps, in regard not only to the extent of glaciers, but also to the position of the watershed and defluent valleys. The Remo glacier-field is found to feed both the Indus and the Yarkand systems, and thus to send some of its water down either slope of the Himalayan system, to the Arabian Sea on one hand, and to the Tarim depression in the Central Asian desert on the other. The expedition is continuing its work, which has been extended into Chinese Turkestan.

THE Russian Supplement which accompanied the *Times* of January 15 dealt mainly with economic aspects of the war as especially affecting that country, and some of them, such as the question of the position of the chemico-pharmaceutical industry, call for scientific attention. The possible development of British and Russian commercial relations is treated of at considerable length, and among other interesting commercial discussions are those dealing with the sudden strain placed upon the port of Archangel, with the arctic sea route to Siberia, and with other facts and problems of communication. In another department we find a study of the distribution of Germans in Russia, accompanied by an instructive map, which shows how Germans have established themselves in greatest numbers in some of the best provinces (not necessarily nearest their own frontier), and how they largely populate also some of the great towns, with important political results. Another article discusses the tribes of the Yenisei valley.

ON several occasions recently, writers in the daily Press have suggested that the barbarous methods of warfare adopted by German forces represent the natural result of close attention to scientific teaching, and we are warned against letting our educational institutions be dominated by the same materialistic spirit. It would be juster to associate the humanities rather than science with the cause of the present war, and to say that whatever success has been achieved by the enemy is due to the application of scientific knowledge. There is, unfortunately, little danger that science will be given a prominent or important place in our schools or universities, or that our public men, officials, and writers will understand that it is not only essential to national welfare, but also in addition an intellectual outlook and a standard of truth. The only literary man who knows these things and endeavours to impress them upon the public mind is Mr. H. G. Wells; and for his efforts to awaken the British people to a sense of what their neglect of systematised natural knowledge signifies, we cannot be too grateful. An article by Mr. Wells in the *Daily Chronicle* of January 19 describes truthfully the discouraging conditions attached to scientific study in this country, and the mental inertia which has to be overcome before use is made of scientific knowledge or expert opinion. He pleads for the organisation of a thinking department for collecting, testing, and developing new ideas, such as was referred to by Lord Selborne in the House of Lords a few days ago, and his forcible words may perhaps stimulate interest in intellectual activity for the benefit of the State. It has never been more necessary than it is now to insist upon fuller recognition of the claims of science in education and in public affairs, and for that reason we hope that Mr. Wells will make further and similar contributions to national enlightenment.

THE evidences in favour of the protective treatment against typhoid fever are of many kinds. There is the analogy between this protective treatment and the protective treatments against cholera, anthrax, and plague. There is the authority of the years of hard work spent by men of science over the bacteriology of the fever. There is the whole strength of the medical profession; Sir William Osler and Sir Lauder Brunton have well said, in the *Times*, what their brethren are saying everywhere. Above all, there is the final and irreversible judgment of nature herself. We read, only a fortnight ago, how she has tested this treatment, in northern France and Belgium. Our men in the field may be divided into three classes: (*a*) fully protected, (*b*) partly protected, (*c*) non-protected. The proportion of cases has been 1, 6, and 16; that is to say, the non-protected have been punished sixteen times more than the protected. We read, only a few days ago, how nature made a similar experiment among the French troops in the field. That seems to be her invariable rule, to pick out the unprotected. How could she do otherwise? What else do we

expect of her? For we have got this protective treatment straight from her; it has been copied out of her book. We protect our men from having typhoid once, by giving them a dose of the very stuff which she gives them to protect them from having typhoid twice. The treatment is not perfect; but it does protect our men from the misery of illness or death, and from the grave offence of spreading infection among their friends. Meanwhile, the anti-vivisection societies are hard at work, doing all that they can to rob our men of this protection; and that by methods which are singularly repugnant to public opinion.

THE announcement that the King has been pleased to approve the grant of a Royal Charter of Incorporation to the Institution of Mining and Metallurgy, is one of interest and importance to those interested in the mining industry, as well as to the profession represented by the institution. Its objects are defined in the charter as for "the advancement of the science and practice of mining in respect of minerals other than coal and of metallurgy in respect of metals other than iron." The institution was founded in 1892, and its founders wisely based qualification for membership upon strictly professional lines, avoiding the temptation, which some other kindred societies were unable to withstand, to open the door wide from considerations of finance. This test for admission to its ranks has been maintained and strengthened in the intervening years, and a high professional standard has been attained by rigidly scrutinising the statements of candidates for admission and by direct inquiry with a view to their confirmation. The council also has the right, which is exercised, to investigate cases of alleged breach of professional conduct, and to expel any member against whom such a charge has been substantiated. In 1905 the membership of the institution was 1324, and at the end of 1914 it was 2500. The institution occupies its own freehold house at No. 1 Finsbury Circus, E.C., and has an ordinary income of more than 5000*l*. Its influence for good in the educational, technical, and professional world has well merited the recognition bestowed upon it by the Crown.

AMETHYSTS were used extensively by the ancient Egyptians, and it has hitherto been a puzzle whence they obtained the stone. In the *Cairo Scientific Journal* for August, 1914, Mr. G. W. Murray reports that he and Mr. C. M. Firth recently found a piece in Wadi Bahan in lower Nubia, and in May this year Mr. G. B. Crookston discovered considerable workings for amethyst near Gebel Abu Diyeiba, and practically on the footpath between the phosphate mines of Wasif and Um Huetat. The workings are very extensive, and the amethysts occur lining cavities in a kind of red granite. These cavities occur along veins in the granite, which run in remarkably straight lines for hundreds of yards.

WITH reference to Dr. Bastian's paper on the production of fungus-germs and other living forms from Zooglœal masses (NATURE, December 24, 1914, p. 462) Dr. Margaret C. W. Young directs attention to work she has carried out on the apparent development of very different forms of living organisms from a single parent one. Thus by heating spores of *Bacillus subtilis* in a weak alkaline solution to 110° C., colonies of cocci, streptococci, and yeasts were observed to develop. By other treatment *subtilis* cultures seemed to pass into protozoal stages. Dr. Young holds that bacteria of the *B. subtilis* and *mesentericus* groups are really sporozoites of a protozoon the life-history of which embraces amœboid, flagellate, sporulating, and granular forms. In this, the sexual part of the cycle, the organism is almost invariably parasitic. Outside the host, it exists in fungal forms which may range from a coccus to an aspergillus (*British Medical Journal*, September 25, 1909, and October 3, 1914).

TO Captain Stanley Flower, director of the Giza Zoological Gardens, we are indebted for a copy of a new issue of his list of the zoological gardens of the world, apparently published at Cairo. In normal times the list should have been revised up to the end of 1914, and published in January, 1915; but the war rendered this impracticable, and it is therefore corrected only down to the end of July last. The entries include 166 different establishments, public and private.

IN NATURE of July 9, 1914 (p. 478), a letter was published from Mr. Lydekker in which it was stated that an okapi sent home by Dr. Christy from the Belgian Congo had been mounted with true horny sheaths on the bony horn-cores. To make sure that there had been no mistake Mr. Lydekker wrote to Dr. Christy, who is now in the Congo, asking whether the animal had been correctly mounted in this respect. We understand that in a reply just received Dr. Christy says, "quite correct."

THE opening article in the January number of the *Museums Journal* is devoted to the Royal Natural History Museum of Belgium (see p. 404). Although Belgium possessed natural history collections of considerable value at a much earlier date, it was not until 1846 that the museum in Brussels was placed on a permanent footing, Vicomte du Bus, who did such good work on the fossil whales of the Antwerp Crag, being the first director. A new era in the history of the institution was inaugurated when Dr. E. Dupont was appointed director in 1868. In 1891, under the same director, the transference of the collections to a building in the Parc Leopold, originally constructed for the offices of the old zoological gardens, was completed, and the new museum, as it had now become, was opened by H.M. King Leopold II. The accommodation was soon, however, found to be altogether inadequate for the proper housing and display of the collections; and a comprehensive scheme of additions was planned. Only a portion of this scheme has, however, yet been carried out—the remainder is likely to remain *in nubibus* for many a long year.

THE last number of the Journal of the Quekett Microscopical Club is especially interesting in containing a report of the 500th ordinary meeting. Mr. A. E. Hilton has a useful note on the continuous cultivation of the Mycetozoon *Badhamia utricularis* on moistened bread, to which from time to time there may be

profitably added a mixture of ammonium phosphate and cane-sugar. The minimum visibile (apart from the ultra-microscope) is discussed by Mr. A. A. C. Eliot Merlin, who finds that the diameter of a particle just visible under a 1/12th apochromat with a working aperture of 1·4 is 1/377,358th of an inch. The diameter of the flagellum of *Bacterium termo* was estimated by Dallinger at 1/204,700th of an inch, but Merlin finds it to be about double that, namely, 1/112,200. C. F. Rousselet has a note on the sexual stages of two African species of Volvox, *Volvox africanus* and *V. rousseleti*, the vegetative colonies of which were previously described by Prof. G. S. West. Mr. E. M. Nelson discusses various forms of binocular microscope, a much-needed low-power condenser, and a new object glass produced by Zeiss in which a near approach has been made towards apochromatism without the use of fluorspar. Just as oil immersions have eclipsed water immersions, so will this new lens, according to Mr. Nelson, supersede the wide-angled dry lenses, which should all be scrapped.

THE Kew Bulletin, No. 10, 1914, contains a paper on *Hedychium coronarium* and allied species, which is of value in connection with the interest aroused in these plants as a source of material for paper-making. The eight allied species are chiefly distinguished by the floral characters, of which illustrations are given. It seems probable that all these Hedychiums would be useful for paper-making. It will be remembered that the paper made from this plant is self-sized, and can be written upon with ink directly it leaves the machine without further treatment.

THE native plants of the Azores are discussed by Dr. H. B. Guppy in *Kew Bulletin*, No. 9, 1914. The vegetation of the mountain of Pico, 7613 ft., was particularly studied, with its European flora on the higher levels—ling, St. Dabeoc's heath, thyme, etc.—and the characteristic Azorean plants below 5000 ft., such as *Erica azorica*, *Juniperus oxycedrus*, and the Azorean holly, *Ilex perado*. The Faya tree, *Myrica faya*, is a dominant tree in the lower woods, but the forest trees generally are small, owing to the depredations of the wood-cutters. The indigenous plants are few, the flora is largely European in character, with a few affinities with Africa and the Canaries, *Myrsine Africana* affording the most remarkable connection with the continent. It seems probable that the flora of the Azores is relatively recent and can be accounted for by existing agencies of dispersal in contrast to the Canaries and Madeira, the flora of which is ancient, dating back probably in part to Miocene times.

THE occurrence of pitchblende in the Quartz Hill district, Gilpin Co., Colorado, is described by Mr. E. S. Bastin in Professional Paper, 90 A, United States Geological Survey (1914). The ore is found in veins with pyrite and copper pyrites, and is connected by the author with Cainozoic intrusions of monzonite (diorite with orthoclase).

SINCE the reference made in NATURE of November 26, 1914 (vol. xciv., p. 348) to the Upper Jurassic fauna of the Spiti Shales of the Himalayas, the study of the mollusca has been continued by Miss Paula Steiger in Vienna (*Palaeontologia Indica*, series xv., vol. iv., fasc. No. 5). The author wisely remarks that the comparison of the brachiopods with Mediterranean forms is due to our far too scanty knowledge of members of the group from other parts of the world. Here we have a hint to palæontologists and collectors.

THE 792 pages of the Annual Report of the Geological Survey of Iowa for 1913, which has just been issued, are almost entirely occupied by an elaborately illustrated account of the materials for roads and concrete throughout the State. This systematic report provides much information about the nature of the glacial and interglacial beds. In places, the imported boulders of gneiss and granite in the thin Iowan drift are as valuable as those in the North German plain, and are similarly collected for use on the macadamised roads.

IN the December number of the *Agricultural Students' Gazette*, Prof. G. S. Boulger discusses some problems of ecology as illustrated by Gloucestershire flowering plants. He divides the factors of ecology into three main groups, (*a*) the inherent characters of the plants, (*b*) the environment, and (*c*) the relations of (*a*) and (*b*). Many species of plants, commonly regarded as characteristic of a particular feature in their normal environment, are found flourishing under conditions where this very feature is notably weak or even absent. Thus, the calcicole or lime-loving Pasque-flower (*Anemone pulsatilla*, Linné) will grow well in a rich garden soil poor in lime; the Bee Orchis (*Ophrys apifera*, Hudson), most commonly found in England on limestone, is also luxuriant on the Upper Lias, near Leckhampton. Again, the Fritillary (*Fritillaria meleagris*, Linné) occurs habitually in meadows liable to inundation, but has been found in a wood near Fairford fully twenty feet above the water level. Another species of riverside plant, the Meadow Crane's-bill (*Geranium pratense*, Linné), abundant by Severn and Avon at Tewkesbury, is not uncommon in seemingly dry hedgerows on the Cotteswolds. Little is known of the precise conditions that determine the topographical distribution of common species, and a plea is put forward for the investigation of these and other interesting problems suggested in the paper.

WE have been favoured with a copy of an interesting address by Dr. F. A. Carpenter (local forecaster) entitled "Flood Studies at Los Angeles," reprinted from the U.S. *Monthly Weather Review* of June last. The object of the paper (which is accompanied by tables and diagrams) is to explain, generally, some of the causes and pertinent features of such rain storms, and to investigate more particularly that of February 18–21, 1914. The rainfall of South California is subject to great variations; the average annual fall at Los Angeles is 15·5 in., the extremes being 5·6 in. (1898–9), and 38·2 in. (1883–4). Rain only occurs during parts of the year; South California would be practically rainless were it not for the southern deflection of the paths of some of the

northern storms. During the past thirty-seven years the harbour of San Pedro (near Los Angeles) has only been silted up five times by floods, although the latter are of frequent occurrence. When the first rain is steady it soaks into the land, and no floods occur; but during the next period of rainy weather they generally take place. Dr. Carpenter's useful paper should be read in conjunction with Prof. A. G. McAdie's elaborate memoir on the "Rainfall of California" (NATURE, October 15, 1914).

IT is not so long ago that *Punch* published a cartoon of artists painting pictures intended to represent "old masters," of which one-half had been restored by a particular process. In the *Museums Journal* Mr. I. J. Williams, of the Welsh National Museum, describes his experiences in cleaning pictures himself after vainly attempting to obtain satisfactory results by employing outsiders. The process is, of course, comparatively simple, involving nothing more than rubbing off the old varnish with cotton-wool dipped in a mixture of four parts of methylated spirit to one of turpentine, but he finds that considerable skill is required in stopping the process at exactly the right stage. With a view to the future preservation of the pictures it would, however, be desirable to make very careful inquiries as to the character of the varnish subsequently used, as it is not improbable that the old varnishes were better than any now obtainable.

OWING to the decreased output of scientific work in consequence of the war the concluding numbers of *Science Abstracts* for the year 1914 are somewhat less extensive than usual. The physics part consists of forty pages of abstracts and four of index, and the electrical engineering part of thirty-one and four pages respectively. The actual number of abstracts in the two parts is 104 and sixty-two. The average length of the engineering continues to be greater than that of the physics abstract, mainly on account of descriptions of engineering plant. Both sections of the publication continue to supply up-to-date and trustworthy information as to the advances made in many fields, and it is difficult to see how any scientific or technical worker in either subject could now dispense with *Science Abstracts*.

ACCORDING to an editorial note in the *Scientific American* for December 26, 1914, a series of articles will be published early in the present year dealing with the necessity of encouraging in every possible way the scientific researcher in order to make the industries of America more independent of Europe. The editor is of opinion that many manufacturers who at present depend on Europe for some portion of their raw material for technical processes could, by stating their difficulties to a man of science willing to undertake the necessary research, obtain at a relatively small cost information which would place them on a much firmer footing. We have no doubt these articles will be read with interest in this country, as the attitude of the British manufacturer towards research is by no means so cordial as it ought to be.

A POPULAR edition of Prince Kropotkin's "Mutual Aid: A Factor of Evolution," has been published by Mr. William Heinemann, at the price of 1s. net. This cheap re-issue of an important work appears at an opportune moment. Many German writers are excusing the horrors of the war by representing them as unavoidable consequences of the struggle for existence. As our review of the first edition of "Mutual Aid," in the issue of NATURE for January 1, 1903 (vol. lxvii., p. 196), pointed out, Prince Kropotkin shows that in the case of animals, there is very little evidence of any struggle for existence among members of the same species, and no justification can be found for the crude conception of Darwinism which places selfish interests among the desirable attributes of the human race. We welcome this cheap edition of Prince Kropotkin's noteworthy exposition of evolutionary ethics, and we hope it will have the wide circulation its lucidity and charm deserve.

THE Cambridge University Press will shortly issue a new edition—the third—of "Zoology," by Drs. Shipley and MacBride. The work has been thoroughly revised, many portions being re-written, and several new illustrations added.—Messrs. Methuen and Co., Ltd., announce the forthcoming publication of a further selection of Sir E. Ray Lankester's popular science articles. It will be entitled "Diversions of a Naturalist."

OUR ASTRONOMICAL COLUMN.

SPECTRAL LINE DISPLACEMENTS AT THE SUN'S LIMB.—As a further research in connection with the work carried on at the Kodaikanal Observatory on the displacement of spectrum lines at the sun's limb, Mr. A. A. Narayana Ayyar contributes to Bulletin No. 44 of the Kodaikanal Observatory the results of his work on the displacements at the sun's limb of lines sensitive to pressure and density. It is pointed out that certain lines, particularly those of calcium and sodium, are much more sensitive to pressure and density than iron lines, and that therefore the limb shifts of such lines should provide a much more rigorous test as to whether there is a large difference of pressure and density between the sun's limb and centre. The paper gives the experimental details, and the result arrived at is that the difference of pressure and density between the limb and centre is very small, a conclusion in agreement with that derived by Messrs. Evershed and Royds. The balance of evidence, as the author states, is in favour of slightly lower pressure and density at the limb than at the centre of the disc.

STATISTICS OF SPECTROSCOPIC BINARY STARS.—In the *Arkiv för Matematik, Astronomi och Fysik* (vol. x., No. 6) of the Stockholm Academy, Dr. Sven Wicksell contributes a paper on the statistics of spectroscopic binary stars. Referring in the first instance to the important investigations and discussions by Campbell, Schlesinger, Baker, Ludendorff, etc., he attempts to find out other interesting properties of spectroscopic binaries. Constructing a card-catalogue of 440 binaries, he found it was composed of 104 systems, of which the period was known, seventy-nine in which the semi-amplitude of radial velocity was known and seventy-five in which the excentricity was known. All these he divided into four classes, according to their spectral type, and arranged them in tabular form. The investigation is devoted to the study of the frequency curves of the period, the explanation of the existence of two groups of periods, a reference to Shapley's investigation of eclipsing binaries, etc.,

and, finally, the distribution of spectroscopic binaries as regards the Milky Way.

THE NATURE AND CAUSE OF CEPHEID VARIATION.—Dr. Harlow Shapley, in the December number of the *Astrophysical Journal* (vol. xl., No. 5, p. 448) presents a discussion on the nature and cause of Cepheid variation, in which he investigates the question of whether or not the usually accepted double-star interpretation of Cepheid variation should be abandoned. From the spectroscopic point of view alone, he states, the Cepheids stand out as unexplainable anomalies. There are persistent peculiarities in the spectroscopic elements, a universal absence of a secondary spectrum, and minute apparent orbits. They do exhibit definite periodic oscillations of their spectral lines, as is the case with ordinary spectroscopic binaries, which may be interpreted as periodic orbital motion. In the present discussion, which the author considers only as preliminary, no complete explanation of Cepheid variation is offered as a substitute for the existing inadequate theories, but he points out the direction in which he thinks the real interpretation seems to lie. The sections of the present paper are devoted to the principal results which he has obtained from an extensive investigation, details of which will be published in subsequent papers. The main conclusion which he has reached is summed up by him as follows:—"That the Cepheid and cluster variables are not binary systems, and that the explanation of their light-changes can much more likely be found in a consideration of internal or surface pulsations of isolated stellar bodies."

THE PREHISTORIC SOCIETY OF EAST ANGLIA.

MR. MILLER CHRISTY, in the Proceedings of the Prehistoric Society of East Anglia, 1913–14, discusses the curious engraved shell from the Red Crag at Walton-on-the-Naze, which has formed the subject of much controversy since it was exhibited at the York meeting of the British Association in 1881. It is a crude and inartistic attempt to depict a human portrait. It is much ruder in its execution than the celebrated drawings of the human figure from the French caves and the Bushman drawings from South Africa. It also differs from other drawings of this kind as it represents, not a profile, but a full face. The characteristics of this supposed portrait have been investigated by a special committee, and on the whole Mr. Christy is disposed to agree with its members that the evidence is insufficient to enable us to reach any definite conclusion regarding its age.

Under the title of "An Early Norfolk Trackway: The Drove Road," Messrs. W. G. Clarke and H. D. Hewitt describe a supposed ancient trackway, fourteen miles in length, connecting the fenland at Blackdike, Hockwold, with Peddar's Way on Roudham Heath. There are some indications that this was an ancient route, but the evidence adduced in support of the conclusion that it is of extreme antiquity is not quite conclusive. In its original state it possesses many points of resemblance to known prehistoric trackways in East Anglia and other parts of England; it is subsidiary to Peddar's Way, and it is also connected with the Pilgrim's Walk; in relation to the Fendyke it resembles the Icknield Way, which is certainly prehistoric; roads from Saxon settlements were in some cases diverted from their natural course by the Drove; there are barrows in the vicinity, and flint implements and ancient pottery have been found in the neighbourhood. Another similar road near Norwich is described by Mr. Walter Rye in the same issue of the Proceedings.

ANNUAL MEETING OF THE PARIS ACADEMY OF SCIENCES.[1]

THE year just ended has been broken by a formidable discontinuity. In the first period our work has followed its usual course; in the second, it has been dominated by the constant thought of national defence.

The importance of the rôle of our academy grows from year to year. Nearly all the development of modern civilisation takes its roots in scientific research; that is to say, in the study, the co-ordination and the generalisation of those facts and ideas which lend themselves to exact measurements or precise comparisons. The domain of science thus understood is unlimited; it ranges from the highest abstractions to the most practical applications, from the world of stars and nebulæ to that of atoms and molecules; from the mechanics of worlds to factories, to armoured vessels, and to aeroplanes; from the delicate phenomena of physics and chemistry to the great industries, to telephony, to wireless telegraphy, and to explosives; from the most complex living organisms in the present and the past to microscopic beings; from the experiments of physiology and microbiology to agriculture, medicine, and surgery. If, at all times, the evolution of philosophy has followed that of science, modern work on the principles of geometry and mechanics, the examination of the ideas of space and time, the daring attempts to connect simultaneously these two ideas with the theory of groups of transformations, have opened entirely new paths in the study of the foundations of our knowledge.

The search for scientific truth by a mind enamoured of moral beauty is the noblest aim of mankind. But the study of science, deflected from the steady ideal of right and humanity, confined to the path of a narrow specialisation, disciplined with a view to domination and reduced principally to practical use, leads rapidly to a civilisation of selfishness, hardness, and materialism, to a kind of learned barbarity like that which has gradually overgrown the Germany of the present day. Granted that the acquisition of the scientific spirit is indispensable to education, other elements should be joined to it to form a man worthy of the name, and these are presented to us by the "humanities," which are studied by our colleagues of the other academies; philosophy and history, religious and social science, the rights of individuals or of nations, the creations of thinkers or of artists.

Instruction and erudition must not be confused with education, the laborious work of acquiring knowledge with the development of civilisation. True education ought to create a personal religion, a conscience increasing in sensitiveness and loftiness of ideal, the love of clearness, the power of forming general ideas, devotion to justice, respect for other men.

This is the well-balanced culture after which France has always sought; it is this which is threatened to-day; at the sight of this danger Prof. Murray Butler, of Columbia University, has said:—

"What are we to think? Is science a sham? Is philosophy a pretence? Is religion a mere rumour? Is the great international structure of friendship, good-will, and scholarly co-operation upon which this university and many of its members have worked so long, so faithfully, and apparently with so much success, only an illusion? Are the long and devoted labours of scholars and of statesmen to enthrone Justice in the place of Brute Force in the world, all without effect? The answer is No; a thousand times, No!"

The American conscience has thus formulated the

[1] Translation of the main part of the address delivered on December 21, 1914, by the president, M. Paul Appell.

universal reply, which is a certain proof of victory for our ideal.

Amongst the scientific events of the year, prominent mention is due to the unveiling of the monument of our colleague Marey, one of those men to whom modern physiology owes so much. As M. Richet has said ("Inauguration du monument élevé à la memoire de Etienne Jules Marey, au Parc des Princes, à Boulogne-sur-Seine, le mercredi 3 Juin, 1914"; Paris: Gauthier-Villars), he is one of those who leave a work so firm, so fruitful, so perfect that every year adds to its renown. In fact, time takes no toll on a well-founded scientific work. The pages of Descartes on "la Géométrie analytique," of Harvey on "the contractions of the heart," of Lavoisier on "les combustions respiratoires," remain intact and intangible, like the Greek marble statues, the beauty of which remains unchanged after a lapse of twenty centuries. The idea conceived by Marey in his youth and realised by him in his work was the creation of methods permitting the direct and precise inscription of motion, either by graphical records, or by photographs taken at intervals so short as to appear continuous. A running man, a galloping horse, a flying bird, a beating heart, execute movements only a confused average of which can be seized by the eye. The photographs of Marey give an exact analysis of them; it is only necessary to realise the synthesis of the successive images by the aid of a method employed a long time ago in certain toys to obtain a kinematograph. This apparatus, possessing innumerable scientific applications, has then its origin in the work of Marey.

It presents the great philosophic interest of giving control of the time, which, until then, had been the one independent variable. Once a phenomenon is recorded it can be repeated in its successive phases, accelerating or retarding at will. Thus deceleration permits the study at leisure of the beats of the heart, the movements of a bird's wings, and acceleration shows in a few minutes the germination of a plant or the hatching of an egg. It is even possible to change the sign of the variable and reverse the order of events. Marey then was an inventor of genius, a man who extracted something from nothing; the improvement of a discovery is a small matter, the essential point is to make it.

This year French physicists have been actively occupied with the construction of a huge electromagnet, in which the intensity and dimensions of the field were to be much greater than those of the most powerful apparatus in current use. A magnet of this nature would permit of absolutely new researches on the magnetic properties of matter at different temperatures, on the constitution of crystals, on Zeeman's phenomenon, rotatory magnetic polarisation, and, in another order of work, on modifications of vital phenomena under the action of the magnetic field. The council of the Faculty of Science of Paris, struck with the importance of these researches, had reserved from the funds placed at its disposition by the liberality of M. Commercy for the advancement of science a sum of 50,000 francs, as a first contribution, although small, to the total expenditure required for the realisation of the scheme. Prince Bonaparte, who is always ready with active generosity to support great French scientific enterprises, has taken an active interest in this question. At his request an official committee, composed of the most competent members of our academy, was constituted, in order to study under what conditions France could be endowed with an instrument that should be unique in the world. This committee has held numerous meetings to discuss the various suggestions and hear the best-known specialists; its results have been published in a pamphlet which is a credit to our academy. Without quoting any names, the conclusions may be summarised thus: it is desirable that an important laboratory of magnetic research should be created; this laboratory should be placed under the patronage of the academy, and administered by the University of Paris; in this laboratory should be installed the most powerful electromagnets of the types chosen.

While we are thus dreaming of a gigantic magnet destined to enlarge the field of human knowledge, Germany, carried away by its dream of world-domination, prepared in secret enormous mortars in view of a sudden overwhelming attack on Belgian and French fortresses; when the time was thought favourable, war was declared against Russia and France, and Belgian neutrality was violated. Since the first days in August our academy has had but one thought, to assist the Government in the defence of the country and liberty.

At the meeting of August 3, the academy notified the Government that all its members who were not mobilised in the public service held themselves in readiness to aid in the national defence, each according to his speciality. After the meeting six large committees were constituted under the following denominations:—(1) Mechanics (including Aviation); (2) Wireless Telegraphy; (3) Radiography; (4) Chemistry (including Explosives); (5) Medicine, Surgery, Hygiene; (6) Food. All these committees have worked their hardest; the time has not come to speak of the reports which they have presented and the results they have obtained.

On August 10 the academy addressed to its correspondants in Belgium, M. Boulvin at Ghent, and M. Francotte at Brussels, the expression of its brotherly friendship and its profound admiration for the Belgian people and army. We solemnly renew to-day the expression of these sentiments, adding our indignant protest against the destruction of the treasures of art and science; the acts of violence on the liberty, life, and property of the non-combatants, committed deliberately in order to punish noble nations because they did not hesitate in their choice between the laws of honour, the respect for treaties, the love of independence, and the base suggestions of material interest or of fear.

MATHEMATICS IN ARTILLERY SCIENCE.

SIR GEORGE GREENHILL, president of the Mathematical Association, delivered an address upon "Mathematics in Artillery Science" at the annual meeting of the association on January 9. We have been unable to obtain a copy of the address from the officials of the association, though we think that one of the chief purposes of a scientific society should be to secure as wide a publicity as possible for its papers and addresses. Sir George Greenhill's remarks have, however, been summarised in the daily papers, and from the *Times* report the subjoined abstract has been derived. We may add that as Sir George was formerly professor of mathematics in the Artillery College, Woolwich, his opinions upon the position which science occupies in our technical training for modern warfare must be given careful consideration.

Six months ago artillery officers would have said there was no such thing as mathematics in artillery science; but that outlook was now ancient history, for at the present time we are engaged in what is, in fact, a mathematical war. Drawing upon his experience as a professor of artillery theory for in-

stances where science would prove itself useful on service, he explained how particulars of the enemy's guns could be deduced from fragments of the wall of a shell and photographic pictures. From a fragment they could determine whether a shell came from one of the 42-centimetre howitzers, the very existence of which still appeared in doubt. Dealing with the calculations for ascertaining how far men should stand from a gun to avoid the danger of permanent deafness, he said they need not fear to stand 12 yards behind the 42-centimetre howitzer; and so the story was discounted of the firing party taking cover 100 to 200 metres away when this howitzer was fired. An application of the theory of the conduction of heat would have reassured our men that life in the trenches would not be too cold, or would at least be warmer than in the frost above, provided only the floor could be drained dry under foot. It had also to be borne in mind that the trench gave better cover than a tent.

Five years ago he had an invitation to Berlin, to visit the Military Technical Academy there. It was a magnificent institution such as we could not afford, so our rulers assured us. Prof. Cranz showed how in his department no money was spared in recent equipment, including a bomb-proof range available for artillery fire and yet in the heart of a big city. There were plenty of outdoor artillery ranges also to visit, where instructive work was in progress. The Perry system of education was adopted in Berlin. After a lecture on wireless telegraphy, the class was set to work, as he saw, in making the antennæ which had played such an important part in the war. Sixty officers were under instruction at a time for a course of three years, and he was assured their zeal was admirable. It was considered such bad form not to give the best in return for the honour and glory of the Fatherland. But our Regular was apathetic by comparison. We must put our trust in the junior ranks to push old Apathy from his stool and carry us through this war.

It was a mournful contrast to revert to Woolwich. There they had been evicted and were told to found a new artillery college with the choice of a cellar under some stables or a kitchen and scullery and bare walls in a deserted hospital, there to organise victory and at no expense. With the courage of an Austrian general compelled to maintain his muzzle-loading musket a match for the Prussian needle-gun, the Military Director assured them that there was nothing superior to be found at Greenwich, in the Naval College there lodged in the old Palace. Such dismal, penurious surroundings had a disastrous effect on the *genius loci*, and they never really recovered from a downhearted spirit not calculated for victory. Our military science was under the rule of Thumb, the official genius. His fumbling method was considered a match for disciplined theory.

We saw already how the cost had been well laid out in this war of the Berlin Military Technical Academy, the German jumping off with a lead he was able to keep so far. The finished article of the academy was employed in the dissemination of true theory and in the scientific direction of warlike preparation as at Krupps. Assuming everything for the best for the Allies, and if we lived to go in again at Antwerp, an interesting match would be watched between our artillery science and the German, to see how long it would take us to get the other side out, compared with our own innings and the time we kept our wicket up. No long-range fire, he had been assured, was ever going to be of any use again, involving theoretical calculation. The word was "Gallop up close, to 400 yards, and let them have it."

The country was furious at the way our poor fellows were pounded mercilessly at the start by long-range accurate howitzer fire with no protection from our own side. King George's stirring appeal, "Wake up, England," was intercepted by our rulers, and it was England the Unready again when our Senior Lethargy bumped into the Titanic Energy of the German Empire.

SOME ASPECTS OF PROGRESS IN MODERN ZOOLOGY.[1]

IT is our privilege to live in a time of almost unexampled progress in natural science, a time distinguished alike by discoveries of the first magnitude and by far-reaching changes in method and in point of view. The advances of recent years have revolutionised our conceptions of the structure of matter, and have seriously raised the question of the transmutation of the chemical elements. They have continually extended the proofs of organic evolution, but have at the same time opened wide the door to a re-examination of its conditions, its causes, and its essential nature. Such has been the swiftness of these advances that some effort is still required to realise what remarkable new horizons of discovery they have brought into view. A few years ago the possibility of investigating by direct experiment the internal structure of atoms, or the topographical grouping of hereditary units in the germ-cells, would have seemed a wild dream. To-day these questions stand among the substantial realities of scientific inquiry. And lest we should lose our heads amid advances so sweeping, the principles that guide scientific research have been subjected as never before to critical examination. We have become more circumspect in our attitude towards natural "laws." We have attained to a clearer view of our working hypotheses—of their uses and their limitations. With the best of intentions we do not always succeed in keeping them clear of metaphysics, but at least we have learned to try. We perceive more and more clearly that science does not deal with ultimate problems or with final solutions. In order to live science must move. She attempts no more than to win successive points of vantage which may serve, one after another, as stepping stones to further progress. When these have played their part they are often left behind as the general advance proceeds.

In respect to the practical applications of science we have almost ceased to wonder at incredible prodigies of achievement; yet in some directions they retain a hold on our imagination that daily familiarity cannot shake. Not in our time, at least, will the magnificent conquests of sanitary science and experimental medicine sink to the level of the commonplace. Science here renders her most direct and personal service to human welfare; and here in less direct ways she plays a part in the advance of our civilisation that would have been inconceivable to our fathers. Popular writers delight to portray the naturalist as a kind of reanimated antediluvian, wandering aimlessly in a modern world where he plays the part of a harmless visionary; but what master of romance would have had the ingenuity to put into the head of his mythical naturalist a dream that the construction of the Panama Canal would turn upon our acquaintance with the natural history of the mosquito, or that the health and happiness of nations—nay, their advance in science, letters, and the arts—might depend measurably on the cultivation of our intimacy with the family lives of house-flies, fleas, and creatures of still more dubious antecedents!

[1] Presidential address delivered to the American Association for the Advancement of Science, Philadelphia, December 28, 1914, by Prof. E. B. Wilson.

I.

Fourteen years ago to-night it was my privilege to deliver an address before the American Society of Naturalists, entitled "Aims and Methods of Study in Natural History,"[2] in which I indicated certain important changes that were then rapidly gathering headway in zoology. To-night I once more ask attention to this subject as viewed in the fuller light of the remarkable period of progress through which biology has since been passing. I will not try to range over the whole vast field of zoology or to catalogue its specific advances. I will only permit myself a few rather desultory reflections suggested by a retrospect upon the progress of the past twenty-five years. If my view is not fully rounded, if it is coloured by a long-standing habit of looking at biological phenomena through the eyes of an embryologist, I will make no apology for what I am not able to avoid. Let me remind you also at how many points the boundaries between this and other branches of biology have become obliterated. The traditional separation between zoology and botany, for instance, has lost all significance for such subjects as genetics or cytology. Again, the artificial boundary often set up between zoology and animal physiology has wholly disappeared, owing to the extension of experimental methods to morphology and of comparative methods to physiology. I trust therefore that our brethren in botany and physiology—perhaps I should include also those in psychology—will not take it amiss if I include them with us under the good, old-fashioned name of *naturalists*.

The sum and substance of biological inquiry may be embodied in two questions: What is the living organism, and how has it come to be? We often find it convenient to lay the emphasis on one or the other of these questions, but fundamentally they are inseparable. The existing animal bears the indelible impress of its past; the extinct animal can be comprehended only in the light of the present. For instance, the palæontologist is most directly concerned with problems of the past, but at every step he is confronted by phenomena only to be comprehended through the study of organisms as they now are. Our main causal analysis of evolution must be carried out by experimental studies on existing forms. All this seems self-evident, yet the singular fact is that only in more recent years have students of evolution taken its truth fully to heart. And here lies the key to the modern movement in zoology of which I propose to speak.

I do not wish to dwell on matters of ancient history; but permit me a word concerning the conditions under which this movement first began to take definite shape as the nineteenth century drew towards its close. In the first three decades after the "Origin of Species" studies upon existing animals were largely dominated by efforts to reconstruct their history in the past. Many of us will recall with what ardour naturalists of the time threw themselves into this profoundly interesting task. Many of us afterwards turned to work of widely different type; but have our later interests, I wonder, been keener or more spontaneous than those awakened by the morphological-historical problems, some of them already half forgotten, which we then so eagerly tried to follow? I am disposed to doubt it. The enthusiasm of youth? No doubt; but something more, too. Efforts to solve those problems have in the past often failed; they no longer occupy a place of dominating importance; but they will continue so long as biology endures, because they are the offspring of an ineradicable historical instinct, and their achievement stands secure in the great body of solid fact which they have built into the framework of our science. Says Poincaré: "The advance of science is not comparable to the changes of a city, where old edifices are pitilessly torn down to give place to new, but to the continuous evolution of zoologic types which develop ceaselessly and end by becoming unrecognisable to the common sight, but where an expert eye finds always traces of the prior work of the centuries past. One must not think then that the old-fashioned theories have been sterile and vain."

After all, science impresses us by something more than the cold light of her latest facts and formulas. The drama of progress, whether displayed in the evolution of living things or in man's age-long struggle to comprehend the world of which he is a product, stirs the imagination by a warmer appeal. Without it we should miss something that we fain would keep—something, one may suspect, that has played an important part of the higher levels of scientific achievement.

I seem to have been caught unawares in the act of moralising. If so, let it charitably be set down as an attempt to soften the hard fact that thirty years after the "Origin of Species" we found ourselves growing discontented with the existing methods and results of phylogenetic inquiry and with current explanations of evolution and adaptation. Almost as if by a preconcerted plan, naturalists began to turn aside from historical problems in order to learn more of organisms as they now are. They began to ask themselves whether they had not been over-emphasising the problems of evolution at the cost of those presented by life-processes everywhere before our eyes to-day. They awoke to the insufficiency of their traditional methods of observation and comparison and they turned more and more to the method by which all the great conquests of physico-chemical science had been achieved, that which undertakes the analysis of phenomena by deliberate control of the conditions under which they take place—*the method of experiment*. Its steadily increasing importance is the most salient feature of the new zoology.

Experimental work in zoology is as old as zoology itself; nevertheless, the main movement in this direction belongs to the past two decades. I will make no attempt to trace its development; but let me try to suggest somewhat of its character and consequences by a few outlines of what took place in embryology.

The development of the egg has always cast a peculiar spell on the scientific imagination. As we follow it hour by hour in the living object we witness a spectacular exhibition that seems to bring us very close to the secrets of animal life. It awakens an irrepressible desire to look below the surface of the phenomena, to penetrate the mystery of development. The singular fact, nevertheless, is that during the phylogenetic period of embryological research this great problem, though always before our eyes, seemed almost to be forgotten in our pre-occupation with purely historical questions—such as the origin of vertebrates or of annelids, the homologies of germ-layers, gill-slits or nephridia, and a hundred others of the same type. Now, these questions are, and always will, remain of great interest; but embryology, as at last we came to see, is but indirectly connected with historical problems of this type. The embryologist seeks first of all to attain to some understanding of development. It was therefore a notable event when, in the later 'eighties, a small group of embryologists, headed by Wilhelm Roux, turned away from the historical aspects of embryology and addressed themselves to experiments designed solely to throw light upon the mechanism of development. The full significance

[2] *Science*, N. S., xiii., No. 314, January 4, 1901.

of this step first came home to us in the early 'nineties with Driesch's memorable discovery that by a simple mechanical operation we can at will cause one egg to produce two, or even more than two, perfect embryos. I will not pause to inquire why this result should have seemed so revolutionary. It was as if the scales had fallen from our eyes. With almost a feeling of shock we took the measure of our ignorance and saw the whole problem of development reopened.

The immediate and most important result of this was to stimulate a great number of important objective investigations in embryology. But let me pause for a moment to point out that at nearly the same time a similar reawakening of interest in the experimental investigation of problems of the present became evident in many other directions—for example, in studies on growth and regeneration; on cytology and protozoology; on economic biology; on ecology, the behaviour of animals and their reactions to stimuli; on heredity, variation, and selection. The leaven was indeed at work in almost every field of zoology, and everywhere led to like results. It was a day of rapid obliteration of conventional boundary lines; of revolt from speculative systems towards the concrete and empirical methods of the laboratory; of general and far-reaching extension of experimental methods in our science.

But I will return to embryology. It may be doubted whether any period in the long history of this science has been more productive of varied and important discoveries than that which followed upon its adoption of experimental methods. In one direction the embryologist went forward to investigations that brought him into intimate relations with the physicist, the chemist, the pathologist, and even the surgeon. A flood of light was thrown on the phenomena of development by studies on differentiation, regeneration, transplantation, and grafting; on the development of isolated blastomeres and of egg-fragments; on the symmetry and polarity of the egg; on the relations of development to mechanical, physical, and chemical conditions in the environment; on isolated living cells and tissues, cultivated like micro-organisms, outside the body *in vitro*; on fertilisation, artificial parthenogenesis, and the chemical physiology of development. In respect to the extension of our real knowledge these advances constitute an epoch-making gain to biological science. And yet these same researches afford a most interesting demonstration of how the remoter problems of science, like distant mountain-peaks, seem to recede before us even while our actual knowledge is rapidly advancing. Thirty years after Roux's pioneer researches we find ourselves constrained to admit that in spite of all that we have learned of development the egg has not yet yielded up its inmost secrets. I have referred to the admirable discovery of Driesch concerning the artificial production of twins. That brilliant leader of embryological research had in earlier years sought for an understanding of development along the lines of the mechanistic or physico-chemical analysis, assuming the egg to be essentially a physico-chemical machine. He now admitted his failure and, becoming at last convinced that the quest had from the first been hopeless, threw all his energies into an attempt to resuscitate the half-extinct doctrines of vitalism and to found a new philosophy of the organism. Thus the embryologist, starting from a simple laboratory experiment, strayed further and further from his native land until he found himself at last quite outside the pale of science. He did not always return. Instead, he sometimes made himself a new home—upon occasion even established himself in the honoured occupancy of a university chair of philosophy!

The theme that is here suggested tempts me to a digression, because of the clear light in which it displays the attitude of modern biology towards the study of living things. It is impossible not to admire the keenness of analysis, and often the artistic refinement of skill (which so captivates us, for instance, in the work of M. Bergson) with which the neo-vitalistic writers have set forth their views. For my part, I am ready to go further, admitting freely that the position of these writers *may* at bottom be well grounded. At any rate, it is well for us now and then to be rudely shaken out of the ruts of our accustomed modes of thought by a challenge that forces upon us the question whether we really expect our scalpels and microscopes, our salt-solutions, formulas, and tables of statistics, to tell the whole story of living things. It is, of course, impossible for us to assert that they will. And yet the more we ponder the question the stronger grows our conviction that the "entelechies" and such-like agencies conjured forth by modern vitalism are as sterile for science as the final causes of an earlier philosophy; so that Bacon might have said of the former, as he did of the latter, that they are like the Vestal virgins—dedicated to God, and barren. We must not deal too severely with the naturalist who now and then permits himself an hour of dalliance with them. An uneasy conscience will sooner or later drive him back into his own straight and narrow way with the insistent query: The specific vital agents, *sui generis*, that are postulated by the vitalist—are they sober realities? Can the existence of an "élan vital," of "entelechies," of "psychoids," be experimentally verified? Even if beyond the reach of verification may they still be of practical use in our investigations on living things, or find their justification on larger grounds of scientific expediency. However philosophy may answer, science can find but one reply. *The scientific method is the mechanistic method.* The moment we swerve from it by a single step we set foot in a foreign land where a different idiom from ours is spoken. We have, it is true, no proof whatever of its final validity. We do not adopt the mechanistic view of organic nature as a dogma but only as a practical programme of work, neither more nor less. We know full well that our present mechanistic conceptions of animals and plants have not yet made any approach to a complete solution of the problems of life, whether past or present. This should encourage us to fresh efforts, for just in the present inadequacy of these conceptions lies the assurance of our future progress. But the way of unverifiable (and irrefutable) imaginative constructions is not our way. We must hold fast to the method by which all the great advances in our knowledge of nature have been achieved. We shall make lasting progress only by plodding along the old, hard beaten trail blazed by our scientific fathers—the way of observation, comparison, experiment, analysis, synthesis, prediction, verification. If this seems a prosaic programme we may learn otherwise from great discoverers in every field of science who have demonstrated how free is the play that it gives to the constructive imagination and even to the faculty of artistic creation.

II.

Thus far I have desired to emphasise especially the reawakening of our interest in problems of the present, and the growing importance of experimental methods in our science. It is interesting to observe how these changes have affected our attitude towards the historical problem as displayed in the modern study of genetics. Even here we are struck by the same shifting of the centre of gravity that has been remarked in other fields of inquiry. In the Darwinian era

studies on variation and heredity seemed significant mainly as a means of approach to the problems of evolution. The post-Darwinians awoke once more to the profound interest that lies in the genetic composition and capacities of living things as they now are. They turned aside from general theories of evolution and their deductive application to special problems of descent in order to take up objective experiments on variation and heredity for their own sake. This was not due to any doubts concerning the reality of evolution or to any lack of interest in its problems. It was a policy of masterly inactivity deliberately adopted; for further discussion concerning the causes of evolution had clearly become futile until a more adequate and critical view of existing genetic phenomena had been gained. Investigators in genetics here followed precisely the same impulse that had actuated the embryologists; and they, too, reaped a rich harvest of new discoveries. Foremost among them stands the re-discovery of Mendel's long-forgotten law of heredity—a biological achievement of the first rank which in the year 1900 suddenly illuminated the obscurity in which students of heredity had been groping. Another towering landmark of progress is De Vries's great work on the mutation theory, published a year later, which marked almost as great a transformation in our views of variation and displayed the whole evolution problem in a new light. In the era that followed, the study of heredity quickly became not only an experimental, but almost an exact science, fairly comparable to chemistry in its systematic employment of qualitative and quantitative analysis, synthesis, prediction, and verification. More and more clearly it became evident that the phenomena of heredity are manifestations of definite mechanism in the living body. Microscopical studies on the germ-cells made known an important part of this mechanism and provided us with a simple mechanical explanation of Mendel's law. And suddenly, in the midst of all this, by a kaleidoscopic turn, the fundamental problem of organic evolution crystallises before our eyes into a new form that seems to turn all our previous conceptions topsy-turvy.

I will comment briefly on this latest view of evolution, partly because of its inherent interest, but also because it again exemplifies, as in the case of embryology, that temptation to wander off into metaphysics (*sit venia verbo!*) which seems so often to be engendered by new and telling discoveries in science. The fundamental question which it raises shows an interesting analogy to that encountered in the study of embryology, and may conveniently be approached from this side.

To judge by its external aspects, individual employment, like evolution, would seem to proceed from the simple to the complex; but is this true when we consider its inner or essential nature? The egg *appears* to the eye far simpler than the adult; yet genetic experiment seems continually to accumulate evidence that for each independent hereditary trait of the adult the egg contains a corresponding *something* (we know not what) that grows, divides, and is transmitted by cell-division without loss of its specific character and independently of other somethings of like order. Thus arises what I will call the puzzle of the microcosm. Is the appearance of simplicity in the egg illusory? Is the hen's egg fundamentally as complex as the hen, and is development merely the transformation of one kind of complexity into another? Such is the ultimate question of ontogeny, which in one form or another has been debated by embryologists for more than two centuries. We still cannot answer it. If we attempt to do so, each replies according to the dictates of his individual temperament—that is to say, he resorts to some kind of symbolism; and he still remains free to choose that particular form which he finds most convenient, provided it does not stand in the way of practical efforts to advance our real knowledge through observation and experiment. Those who must have everything reduced to hard and fast formulas will no doubt find this rather disconcerting; but worse is to follow. Genetic research now confronts us with essentially the same question as applied to the evolutionary germ. The puzzle of the microcosm has become that of the macrocosm. Were the primitive forms of life really simpler than their apparently more complex descendants? Has organic evolution been from the simple to the complex, or only from one kind of complexity to another? May it even have been from the complex to the simple by successive losses of inhibiting factors which, as they disappear, set free qualities previously held in check? The last of these is the startling question that the president of the British Association propounds in his recent brilliant address at Melbourne, asking us seriously to open our minds to the inquiry: "Whether evolution can at all reasonably be represented as an unpacking of an original complex which contained within itself the whole range of complexity which living things exhibit?" This conception, manifestly, is nearly akin to the theory of pangenesis and individual development, as elaborated especially by De Vries and by Weismann. It inevitably recalls also, if less directly, Bonnet's vision of "palingenesis," which dates from the eighteenth century.

We should be grateful to those who help us to open our minds; and Prof. Bateson, as is his wont, performs this difficult operation in so large and masterly a fashion as to command our lively admiration. It must be said of his picturesque and vigorous discussion that we are kept guessing how far we are expected to take it seriously, or at least literally. We have always a lurking suspicion that possibly his main purpose may, after all, be to remind us, by an object-lesson, how far we still are from comprehending the nature and causes of evolution, and this suspicion is strengthened by the explicit statement in a subsequent address, delivered at Sydney, that our knowledge of the nature of life is "altogether too slender to warrant speculation on these fundamental questions." Let us, however, assume that we are seriously asked to go further and to enter the *cul de sac* that Prof. Bateson so invitingly places in our way. Once within it, evidently we are stalemated in respect to the origin and early history of life; but as to that, one form of total ignorance is perhaps as good as another, and we can still work out how the game has been played, even though we can never find out how the pieces were set up. But has the day so soon arrived when we must resign ourselves to such an ending? Are we prepared to stake so much upon the correctness of a single hypothesis of allelomorphism and dominance? This hypothesis—that of "presence and absence"—has undoubtedly been a potent instrument of investigation; but there are some competent students of genetics who seem to find it equally simple to formulate and analyse the phenomena by the use of a quite different hypothesis, and one that involves no such paradoxical consequences in respect to the nature of evolution. Are we not then invited to strain at a gnat and to swallow a camel?

But I pass over the technical basis of the conception in order to look more broadly at its theoretic superstructure. Is not this, once again, a kind of symbolism by which the endeavour is made to deal with a problem that is for the present out of our reach? Neither you nor I, I dare say, will hesitate to maintain that the primordial Amœba, if we may so dub the

earliest of our ancestors) embodied in some sense or other all the potentialities, for better or for worse, that are realised before us at this moment in the American Association for the Advancement of Science. But if we ask ourselves exactly what we mean by this we discover our total inability to answer in more intelligible terms. We cannot, it is true, even if we would, conquer the temptation now and then to spread the wings of our imagination in the thin atmosphere of these upper regions; and this is no doubt an excellent tonic for the cerebrum provided we cherish no illusions as to what we are about. No embryologist, for example, can help puzzling over what I have called the problem of the microcosm; but he should be perfectly well aware that in striving to picture to his imagination the ultimate organisation of the egg, of the embryological germ, that is actually in his hands for observation and experiment, he is perilously near to the habitat of the mystic and the transcendentalist. The student of evolution is far over the frontier of that forbidden land, in any present attack upon the corresponding problem of the macrocosm; for the primordial Amœba, the evolutionary germ, is inconceivably far out of our reach, hidden behind the veil of a past the beginnings of which lie wholly beyond our ken. And why, after all, should we as yet attempt the exploration of a region which still remains so barren and remote? Surely not for the lack of accessible fields of genetic research that are fertile and varied enough to reward our best efforts, as no one has more forcibly urged or more brilliantly demonstrated by his own example than Prof. Bateson himself.

Perhaps it would be the part of discretion to go no further. But the remarkable questions that Prof. Bateson has raised concerning the nature of evolution leave almost untouched the equally momentous problem as to what has guided its actual course. In approaching my close I shall be bold enough to venture a step in this direction, even one that will bring us upon the hazardous ground of organic adaptations and the theory of natural selection. I need not say that this subject is beset by intricate and baffling difficulties which have made it a veritable bone of contention among naturalists in recent years. In our attempts to meet them we have gone to some curious extremes. On the one hand, some naturalists have in effect abandoned the problem, cutting the Gordian knot with the conclusion that the power of adaptation is something given with organisation itself and as such offers a riddle that is for the present insoluble. In another direction we find attempts to take the problem in flank, to restate it, to ignore it—sometimes, it would almost seem to argue it out of existence. It has been urged in a recent valuable work—by an author, I hasten to say, who fully accepts both the mechanistic philosophy and the principle of selection—that fitness is a reciprocal relation, involving the environment no less than the organism. This is both a true and a suggestive thought; but does it not leave the naturalist floundering amid the same old quicksands? The historical problem with which he has to deal must be grappled at closer quarters. He is everywhere confronted with specific devices in the organism that must have arisen long after the conditions of environment to which they adjusted. Animals that live in water are provided with gills. Were this all we could probably muddle along with the notion that gills are no more than lucky accidents. But we encounter a sticking point in the fact that gills are so often accompanied by a variety of ingenious devices, such as reservoirs, tubes, valves, pumps, strainers, scrubbing brushes, and the like, that are obviously tributary to the main function of breathing. Given water, asks the naturalist, how has all this come into existence and been perfected? The question is an inevitable product of our common sense. The metaphysician, I think, is not he who asks but he who would suppress it.

For all that it would seem that some persons find the very word adaptation of too questionable a reputation for mention in polite scientific society. Allow me to illustrate by a leaf taken from my own notebook. I once ventured to publish a small experimental work on the movements of the fresh-water Hydra with respect to light. What was my surprise to receive a reproof from a friendly critic, because I had not been content with an objective description of the movements but had also been so indiscreet as to emphasise their evident utility to the animal. I was no doubt too young then—I fear I am too old now—to comprehend in what respect I had sinned against the light. That was long ago. I will cite a more recent example from a public discussion on adaptation that took place before the American Society of Naturalists a year or two since. "The dominance of the concept of adaptation," said one naturalist, "which now distinguishes our science from the non-biological ones, is related to the comparatively youthful stage of development so far attained by biology, and *not to any observed character in the living objects with which we deal.*" Here, we almost seem to catch an echo from the utterances of a certain sect of self-styled "scientists" who love to please themselves with the quaint fancy that physical disease is but one of the "errors of mortal mind."

Now, it is undoubtedly true that many adaptations, to cite Prof. Bateson once more, are "not in practice a very close fit." Even the eye, as Helmholtz long ago taught us, has some defects as an optical instrument; nevertheless, it enables us to see well enough to discern some food for reflection concerning adaptations among living things. And it is my impression that efforts to explain adaptations are likely to continue for the reason that naturalists as a body, perhaps influenced by Huxley's definition of science, have an obstinate habit of clinging to their common sense.

At the present day there is no longer the smallest doubt of the great outstanding fact that many complex structural adaptations—it would probably be correct to say all such—have not come into existence at a single stroke but have moved forward step by step to the attainment of their full degree of perfection. What has dominated the direction and final outcome of such advancing lines? We cannot yet answer this question with any degree of assurance; but procrastinate as we may, it must in the end squarely be faced. We have seen one theory after another forced back within narrower lines or crumbling away before the adverse fire of criticism. I will not pause to recount the heavy losses that must be placed to the account of sexual selection, of neo-Lamarckism, of orthogenesis. Some naturalists, no doubt, would assign a prominent place in this list of casualties to natural selection; but probably there are none who would hold that it has been destroyed utterly. The crux lies in the degree of its efficacy. Stated as an irreducible minimum the survival of the fit is an evident fact. Individuals that are unfitted to live, or to reproduce, leave few or no descendants—so much, at least, must be admitted by all. But does this colourless and trite conclusion end the matter or adequately place before us the significance of the facts? Just here lies the whole issue. Does destruction of the unfit accomplish no other result than to maintain the *status quo*, or has it conditioned the direction of progress? Accepting the second of these alternatives, Darwin went so far as to assign to it a

leading rôle among the conditions to which the living world owes its existing configuration. Since his time the aspect of the problem has widely changed. We must rule out the question of the origin of neutral or useless traits. We must not confuse the evolution of adaptations with the origin of species. We must bear in mind the fact that Darwin often failed to distinguish between non-heritable fluctuations and hereditary mutations of small degree. We are now aware that many apparently new variations may be no more than recombination-products of pre-existing elements, We should, no doubt, make a larger allowance for the rôle of single "lucky accidents" in evolution than did many of the earlier evolutionists. And yet, so far as the essence of the principle is concerned, I am bound to make confession of my doubts whether any existing discussion of this problem affords more food for reflection, even to-day, than that contained in the sixth and seventh chapters of the "Origin of Species" and elsewhere in the works of Darwin.

Undeniably there is a large measure of truth in the contention that natural selection still belongs rather to the philosophy than to the science of biology. In spite of many important experimental and critical studies on the subject Darwin's conception still remains to-day in the main what it was in his own time, a theory, a logical construction, based, it is true, on a multitude of facts, yet still awaiting adequate experimental test. Simple though the principle is, its actual effect in nature is determined by conditions that are too intricate and operate through periods too great to be duplicated in the experimental laboratory. Hence it is that even after more than fifty years of Darwinism the time has not yet come for a true estimate of Darwin's proposed solution of the great problem.

But there is still another word to be said. Too often in the past the facile formulas of natural selection have been made use of to carry us lightly over the surface of unsuspected depths that would richly have repaid serious exploration. In a healthy reaction from this purblind course we have made it the mode to minimise Darwin's theory; and no doubt a great service has been rendered to our study of this problem by the critical and sceptical spirit of modern experimental science. But there is a homely German saying that impresses upon us the need of caution as we empty out the bath lest we pour out the child too. This suggests that we should take heed how we under-estimate the one really simple and intelligible explanation of organic adaptations that has thus far been placed in our hands. And in some minds—if I include my own among them let it be set down to that indiscretion at which I have hinted—the impression grows that our preoccupation with the problem as it appears at short focus may in some measure have dimmed our vision of larger outlines that must be viewed at longer range; that we may have emphasised minor difficulties at the cost of a larger truth. To such minds it will seem that the principle of natural selection, while it may not provide a master key to all the riddles of evolution, still looms up as one of the great contributions of modern science to our understanding of nature.

I have taken but a passing glance at a vast and many-sided subject. I have tried to suggest that the tide of speculation in our science has far receded; that experimental methods have taken their rightful place of importance; that we have attained to a truer perspective of past and present in our study of the problems of animal life. The destructive phase through which we have passed has thoroughly cleared the ground for the new constructive era on which we now have entered. All the signs of the times indicate that this era will long endure. And this is of good augury for a future of productive effort, guided by the methods of physico-chemical science, impatient of merely *a priori* constructions, of academic discussions, of hypotheses that cannot be brought to the test of experimental verification. The work ahead will make exacting technical demands upon us. The pioneer days of zoology are past. The naturalist of the future must be thoroughly trained in the methods and results of chemistry and physics. He must prepare himself for a life of intensive research, of high specialisation; but in the future even more than in the past he will wander in vain amid the dry sands of special detail if the larger problems and general aims of his science be not held steadfastly in view. For these are the outstanding beacon lights of progress; and while science viewed at close range seems always to grow more complex, a wider vision shows that her signal discoveries are often singularly simple. This perhaps may help us to keep alive the spirit of the pioneers who led the advances of a simpler age; and it is full of hope for the future.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

BIRMINGHAM.—The Huxley Lecture will be delivered on January 21 by M. Emile Verhaeren (the national poet of Belgium), who has chosen as his subject "L'Esprit Belge."

LONDON.—Among the opening lectures in the Lent Term at the Bedford College for Women are several which are open free to the public without ticket. In the department of geology a series of four lectures on minerals used as gem stones will be given on Thursdays at 5.15 p.m., beginning on January 28, by Dr. A. Hutchinson and Dr. H. H. Thomas. In the botany department Mr. W. Neilson Jones will lecture on Mondays at 5 p.m., beginning on January 18, on phenomena of heredity. There will also be lectures on hygiene, mathematics, physiology, and chemistry.

A COURSE of lectures to the University of London Officers Training Corps on military subjects is being given by the members of the staff of Birkbeck College, London, on Tuesdays, at 8 p.m. The first lecture, on the economics of war, was given on January 19 by the principal of the college, Dr. G. Armitage-Smith. Forthcoming lectures on succeeding Tuesdays are as follows:—"Bacteria," Dr. H. C. I. Gwynne-Vaughan; "Some Past Fights for Freedom," Mr. L. Ricci; "Trench Making," Dr. J. W. Evans; "Report Writing," Mr. J. H. Lobban; "International Law of War on Land," Mr. G. C. Rankin; "Map Making and Map Reading," Dr. J. F. Unstead; "Range Finding," Dr. A. Griffiths; "Explosives," Dr. G. Senter; "War Clouds of Modern Europe," Mr. A. Jones; "An Ancient Drill Book," Mr. F. A. Wright. The lectures are intended primarily for cadets of the Officers Training Corps, but are open to all persons interested, without fee.

A COPY of the "General Information Number" of the Bulletin of the Armour Institute of Technology has been received from Chicago. Full particulars are given of the courses offered in mechanical, electrical, civil, chemical, and fire protection engineering, as well as those in architecture and the industrial arts. Each of these four-year courses represents a carefully balanced group system of studies, combining a thorough and broad scientific training with the elements of liberal culture, and all lead to the degree of bachelor of science.

THE president, vice-president, and council of the Royal College of Surgeons in Ireland have decided to place in the college a permanent record of the names of all the students, licentiates, and fellows of the college who are at present serving with his Majesty's Navy and Expeditionary Forces, and further to erect a suitable memorial to all such as fall in the war. The president, vice-president, and council will be glad if the relatives and friends would communicate the names of such students, licentiates, and fellows to the registrar of the college.

IN an article in *Science* for December 25, Mr. John C. Burg, of North-Western University, Chicago, examines and summarises the registration statistics for November 1, 1914, of some thirty universities in the United States. The largest gains for the year in the number of students were as follows:—Columbia, 1365; California, 1109; Pittsburgh, 1069; Ohio State, 832; Wisconsin, 806; Harvard, 784; New York, 634; Minnesota, 552; Pennsylvania, 536. The eight universities with the largest total number of students are given in the article as:—Columbia, 11,294; California, 8180; Chicago, 7131; Wisconsin, 6696; Pennsylvania, 6505; Harvard, 6411; Michigan, 6319; New York University, 6142. In the scientific schools, that is, including the schools of mines, engineering, chemistry, and related subjects, Illinois takes the lead with 1406 students, followed by Cornell, 1363, Michigan, 1347, Yale, 1056, Pennsylvania, 906, Ohio State, 851, Wisconsin, 796, and California, 763.

IT is announced in the issue of *Science* for January 8 that the sum of 486,000*l.* was obtained for Wellesley College in the fourteen months ended in December, 1914, according to a statement given out by the treasurer. Of this amount 86,000*l.*, including a conditional pledge of 40,000*l.* from the General Educational Board, was raised before the fire of March 17, when College Hall was burned. The remaining 400,000*l.* includes a pledge from the Rockefeller Foundation of 150,000*l.* Only three gifts of more than 2000*l.* were received since last August. One of these was a gift from Mr. Carnegie of 19,000*l.* for the enlargement of the library. From the same source we learn that the Massachusetts Institute of Technology received in gifts during the past year the sum of 80,000*l.*, besides two items wherein the institute is residuary legatee, and the amounts have not been determined. Among the gifts may be mentioned: bequest of Caroline L. W. French (outright), 20,000*l.*; (residue), 20,000*l.*; Lucius Tuttle, 10,000*l.*; and Nathaniel Thayer, 10,000*l.*

THE issue for January of the Technical Journal of the Association of Teachers in Technical Institutions contains an interesting article on the Massachusetts Institute of Technology. This article is written by Dr. Tyler, Walker professor of mathematics, and Mr. R. C. Maclaurin, president of the college. It may be noted that not only is admission to the college regulated by means of entrance examinations, but there is a continual weeding out of those students who do not display the requisite ability and application. New students are examined periodically, and if their work proves to be unsatisfactory they are required to withdraw. Some of our own colleges could copy this system, and thereby show a considerable improvement in their produce. In the same journal there is an article on laboratories for building trade students, by Mr. G. Arnall. This article suggests that the time is ripe for the institution of separate laboratories for such students, in which the testing of cements, timber, ferro-concrete, etc., could be studied practically. The scheme will probably involve considerable modification of building courses, and the author invites his colleagues in this branch of teaching to submit model syllabuses of laboratory experiments.

IN Circular 885, issued on January 11, the Board of Education states that there is likely to be some difficulty in procuring in this country adequate supplies of chemical laboratory glassware. These articles have ordinarily been imported from Germany and Austria, and they have not hitherto been manufactured in this country except in negligible quantities. Steps to ensure the production of chemical glassware in this country are being taken, but in view of the technical and other difficulties which have to be overcome it must necessarily be some considerable time before there can be production on a large and sufficient scale. Having regard to the extent to which many of the manufacturing industries of the country, including some of special value at the present crisis, require chemical glassware for analytical and other purposes connected with the various industrial processes, it is important that every effort should be made to economise in the use of stocks of such ware now in the hands of educational establishments. These stocks should be examined and a careful record kept of quantities and consumption. Every effort should be made to avoid breakages, and it will probably be found possible to economise in the consumption of "Jena" vessels by the substitution in certain cases of other kinds of glass receptacles. Fresh orders should not be given to manufacturers or supplying agencies for the present, where this can possibly be avoided. The Board of Education is confident that local education authorities and schools and colleges will do their best to assist the Government in the matter.

SOCIETIES AND ACADEMIES.

LONDON.

Mathematical Society, January 14.—Sir Joseph Larmor, president, and afterwards Prof. A. E. H. Love, vice-president, in the chair.—Prof. H. M. **Macdonald**: A class of diffraction problems.—H. E. J. **Curzon**: Halphen's transformation.—Dr. A. **Young**: A Christmas problem in probabilities.—W. E. H. **Berwick**: The condition that a quintic equation should be soluble by radicles.—Sir J. **Larmor**: The variation of the earth's angular velocity of rotation.

PARIS.

Academy of Sciences, January 4.—M. A. Perrier in the chair.—G. **Bigourdan**: The rapid testing of small telescopes. The method proposed, which is easily and rapidly carried out, is a relative one, comparison being made with a standard telescope. The instrument is focussed on a square, one centimetre in the side, containing a group of black lines ruled at equal distances. The number of lines in the centimetre varies from 4 to 20, and the white interspaces are equal in width to the black lines. Details of the mode of testing separating power, astigmatism and field are given.—L. **Landouzy**: a flexible and non-inflammable gelatine film, suitable for radiology. A description of the preparation and use of thin gelatine plates designed to replace the ordinary glass-coated plates. The unexposed plates, with cardboard supporting frame, weigh 8 per cent. of the weight of the ordinary plate, and after exposure and removal of the film from the frame, this is reduced to 2·8 per cent. Additional advantages as compared with glass plates are cheapness, non-fragility, flexibility, enabling the plate to be inserted into awkward positions without damage, and as compared with celluloid, non-inflammability and perfection of detail.—Edouard **Heckel**: *Solanum*

Caldasii and the cultural bud mutation of its subterranean parts. This variety has received several names, and in the author's opinion the classification is too artificial. Proofs are given of the mutation of this wild potato.—MM. **Camichel, Eydoux,** and **Lhériaud**: The Venturi meter. A discussion of the accuracy of the Venturi water meter. The theoretical formula is $q=\lambda a\sqrt{p_1-p_2}$, in which q is the quantity, (p_1-p_2) the difference of pressure between the main tube and the construction, and λ a factor less than unity depending on the internal friction of the liquid. Experimental results with a Venturi gauge of 300 mm. diameter, contraction $\frac{1}{4}$, and flow varying from 60 to 160 litres a second. The value of λ was found to be 1, the error of experiment being under 1 per cent. Similar results were obtained with a larger instrument, passing 800 to 3000 litres a second.—Emile **Saillard**: The estimation of saccharose in beet molasses. Inversion method with double neutral polarisation. The method proposed eliminates errors due to the action of alkaline salts upon saccharose and on invert sugar, and also errors caused by the products of the action of alkaline salts upon active nitrogen compounds present in the beet molasses.—N. **Arabu**: Studies on the Tertiary formation of the basin of the Sea of Marmora. The Vindobonian stage of Troade.—J. de **Rey-Pailhade**: The existence of philothion in the crystalline lens of the eyes of animals. Philothion is a special albumen, characterised by the existence in its molecule of labile hydrogen capable of combining with free sulphur at a temperature of 40° C., with production of sulphuretted hydrogen.—M. **Tiffeneau**: The destination of chloralose in the organism and its relations with glycuronic compounds. In the dog, chloralose is eliminated in part unchanged, and partly in the form of a new acid, chloralose-glycuronic acid. Chloralose does not give rise to chloral and glucose in the organism, and its physiological effects are not due to the chloral it contains.

New South Wales.

Linnean Society, November 25, 1914.—Mr. W. S. Dun, president, in the chair.—A. M. **Lea**: Descriptions of new species of Australian Coleoptera. Part x. Three genera and forty-eight species (families Lucanidæ, Malacodermidæ, Curculionidæ, and Chrysomelidæ) are described as new.—C. **Hedley**: Studies on Australian Mollusca. Part xii. This paper continues the subject of previous communications, and embraces notes gathered abroad in the British and other museums. The Australian species formerly grouped under Voluta are enumerated, revised, and arranged in modern genera. A partial revision of Thais and Zafra is attempted, and various critical species of Arcularia, Montfortia, Tallorbis, and Acmæa are discussed.—L. A. **Cotton**: The diamond-deposits of Copeton, New South Wales. A description of the variations in the Tertiary stream-deposits is given, together with the relations of these to the distribution of the diamonds. The investigation has made clear the relations of the various parts of the Tertiary leads, and, incidentally, has suggested an interesting physiographical feature. It is pointed out that it is highly probable that the Gwydir and Macintyre Rivers of Tertiary times originally formed one stream uniting a little to the west of Inverell. An important discovery was made by Mr. A. R. Pike, in 1904, which has a significant bearing on the origin of the diamond. This was the finding of a diamond in a matrix of dolerite. Later investigation has indicated that it is probable that most, if not all, the diamonds in the field have been derived from this type of rock.—Dr. R. **Greig-Smith**: Contributions to a knowledge of soil-fertility. No. xii.—The action of toluene upon the soil-protozoa. The action of toluene upon the protozoa of the soil depends upon the moisture-content. When less than one-tenth of the water-holding capacity of the soil is present, certain members of the Ciliates, Amœbæ and Flagellates may not be destroyed when amounts up to 20 per cent. of toluene are added to the soil. If more than one-tenth of the water-holding capacity is present, the Ciliates are destroyed by 1 per cent. or 2 per cent. of toluene, while the action upon the Amœbæ and Flagellates is irregular. Conditions which destroy the sulphur-oxidising bacteria, also destroy the Ciliates.—Rev. W. W. **Watts**: Some notes on the ferns of North Queensland. These notes are the result of a trip through the Cairns district, as far south as Bartle Frere and the Russell River, and as far west as the Tully Falls.—Archdeacon F. E. **Haviland**: The pollination of *Goodenia cycloptera*, R. Br. *G. cycloptera*, R. Br., is a decumbent species, in this State, generally restricted to the western plains. The process of pollination, as the result of three years' observation, is described.—A. F. Basset **Hull**: A collection of fossil Polyplacophora from N.W. Tasmania, with descriptions of three new species. In addition to valves of *Lorica duniana*, Hull, and *Chiton fossinus*, Ashby and Torr, the collection studied comprised the remains of three strongly marked species of Loricella, hitherto undescribed. The fossils are from the well-known beds between Wynyard and Table Cape.

BOOKS RECEIVED.

Scottish National Antarctic Expedition. *Scotia* Collection of Atlantic Fishes. By R. S. Clark. Pp. 379–401+2 maps. (Edinburgh: Scottish Oceanographical Laboratory.) 1*s.* 3*d.*

Scottish National Antarctic Expedition. The Whale Fisheries of the Falkland Islands and Dependencies. By T. E. Salvesen. Pp. 479–486+10 plates and text map. (Edinburgh: Scottish Oceanographical Laboratory.) 3*s.*

Ordnance Survey. Professional Papers. New series. No. 3. Notes on the Geodesy of the British Isles. By Col. C. F. Close. Pp. 33. (London: H.M.S.O.; Wyman and Sons, Ltd.) 1*s.* 6*d.*

Willing's Press Guide. Forty-second year. Pp. 470. (London: J. Willing, Ltd.) 1*s.*

A Treatise on the Analytic Geometry of Three Dimensions. By Dr. G. Salmon. Edited by R. A. P. Rogers. Fifth edition. Vol. ii. Pp. xvi+334. (London: Longmans and Co.; Dublin: Hodges, Figgis and Co., Ltd.) 7*s.* 6*d.* net.

War Map of Central Europe, after B. V. Darbishire's Wall Map. (Oxford University Press.) 3*d.* net.

The Teaching of Algebra (including Trigonometry). By Prof. T. P. Nunn. Pp. xiv+616. (London: Longmans and Co.) 7*s.* 6*d.*

Exercises in Algebra (including Trigonometry). By Prof. T. P. Nunn. Part 1. Pp. x+356+Answers, pp. 357–421. Part 2. Pp. xi+514+Answers, pp. 515–551. (London: Longmans and Co.) 4*s.* and 6*s.* 6*d.* respectively.

Artificial Waterways of the World. By A. B. Hepburn. Pp. xi+171. (London: Macmillan and Co., Ltd.) 5*s.* 6*d.* net.

An Introduction to Field Archæology as Illustrated by Hampshire. By Dr. J. P. Williams-Freeman. Pp. xxii+462. (London: Macmillan and Co., Ltd.) 15*s.* net.

Carnegie Endowment for International Peace. Year Book for 1913–14. Pp. xviii+203. (Washington, D.C.)

How Belgium Saved Europe. By Dr. C. Sarolea. Pp. x+226. (London: W. Heinemann.) 2*s.* net.

The Laws of Algebra. By A. G. Cracknell. Pp. vi+68. (London: University Tutorial Press, Ltd.) 1s.

The Substance of Faith Allied with Science. By Sir Oliver Lodge. Cheap edition. Pp. xii+135. (London: Methuen and Co., Ltd.) 1s. net.

Bacon's 6d. Contour Atlas. South Scotland edition. (London: G. W. Bacon and Co., Ltd.) 6d. net.

A Manual of Chemistry, Theoretical and Practical, Inorganic and Organic. By Dr. A. P. Luff and H. C. H. Candy. Fifth edition. Pp. xix+660. (London: Cassell and Co., Ltd.) 8s. 6d. net.

Proceedings of the London Mathematical Society. Second series. Vol. xiii. Pp. liii+500. (London: F. Hodgson.) 25s.

Mutual Aid: a Factor of Evolution. By P. Kropotkin. Popular edition. Pp. x+240. (London: W. Heinemann.) 1s. net.

Annuaire pour l'an 1915. Publié par le Bureau des Longitudes. (Paris: Gauthier-Villars et Cie.)

Workshop Arithmetic. By F. Castle. Pp. viii+172. (London: Macmillan and Co., Ltd.) 1s. 6d.

Plane Trigonometry. By Prof. H. S. Carslaw. New edition. Pp. xviii+293+Answers, pp. xi. (London: Macmillan and Co., Ltd.) 4s. 6d.

Solutions to the Questions in Plane Trigonometry. By Prof. H. S. Carslaw. Pp. 179. (London: Macmillan and Co., Ltd.) 6s. 6d. net.

The Home of the Blizzard: being the Story of the Australasian Antarctic Expedition, 1911–14. By Sir D. Mawson. Vol. i. Pp. xxx+349. Vol. ii. Pp. xiii+338. (London: W. Heinemann.) Two vols., 36s. net.

Wild Life Conservation in Theory and Practice. By Dr. W. T. Hornaday. With a chapter on Private Game Preserves, by F. C. Walcott. Pp. vi+240. (New Haven, Conn.: Yale University Press; Oxford University Press.) 6s. 6d. net.

DIARY OF SOCIETIES.

THURSDAY, JANUARY 21.

ROYAL SOCIETY, at 4.30.—Atmospheric Electricity Potential Gradient at Kew Observatory, 1898–1912: Dr. C. Chree.—The Transmission of Electric Waves over the Surface of the Earth: Prof. A. E. H. Love.—Electromagnetic Waves in a Perfectly Conducting Tube: L. Silberstein. An Electrically-heated Full Radiator: H. B. Keene.

ROYAL INSTITUTION, at 3.—Modern Theories and Methods in Medicine: H. G. Plimmer.

ROYAL SOCIETY OF ARTS, at 4.30.—Nepal: H. J. Elwes.

LINNEAN SOCIETY, at 5.—Report on the Fishes Collected by Mr. Cyril Crossland in the Sudan: Miss Ruth C. Bamber.—Narrative of his Recent Visit to the Houtman Abrolhos Archipelago, West Australia: Prof. W. J. Dakin.

INSTITUTION OF MINING AND METALLURGY, at 8.—Inflammable Natural Gas as an Economic Mineral: J. A. Leo Henderson and W. H. Henderson.—Investigations in Ore Milling to ascertain the Heat Developed in Crushing: J. Cook.

FRIDAY, JANUARY 22.

ROYAL INSTITUTION, at 9.—Problems of Hydrogen and the Rare Gases: Sir J. Dewar.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Standardisation of Pipe Flanges and Flanged Fittings: J. Dewrance.

PHYSICAL SOCIETY, at 5.—Practical Harmonic Analysis: Dr. A. Russell.—Measuring the Focal Length of a Photographic Lens: T. Smith.

SATURDAY, JANUARY 23.

ROYAL INSTITUTION, at 3.—Aerial Navigation—Scientific Principles: Dr. R. T. Glazebrook.

MONDAY, JANUARY 25.

ROYAL SOCIETY OF ARTS, at 8.—Oils, their Production and Manufacture: Dr. F. Mollwo Perkin.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—The Historical and Physica Geography of the Theatres of War: Dr. Vaughan Cornish.

INSTITUTE OF ACTUARIES, at 5.—The Analysis of Life Office Expenses: C. H. Maltby.

TUESDAY, JANUARY 26.

ROYAL INSTITUTION, at 3.—Muscle in the Service of Nerve: Prof. C. S. Sherrington.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.30.—President's Address: The Slav and Allied Racial Elements in the Peoples of Western Europe: Dr. A. Keith.

ROYAL SOCIETY OF ARTS, at 4.30.—The Economic Development of British East Africa and Uganda: Major E. H. M. Leggett.

WIRELESS SOCIETY, at 8.—Presidential Address: Some Electrical Phenomena: A. A. Campbell Swinton.

MINERALOGICAL SOCIETY, at 5.30.—Note on the Colour of some Alluvial Diamonds and Pyrrhotite: F. P. Mennell.—(1) Crystals of Calomel from Spain: (2) General Formula for the Birefringence of a Crystalplate in terms of the Angles which its normal makes with the Optical Principal Axes: (3) A Numerical Relation of the Sum of the Symmetry-axes situated in the Symmetry-planes of a Polyhedron: Prof. G. Cesàro.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Discussion:* The Lateral Pressure and Resistance of Clay, and the Supporting Power of Clay Foundations: A. L. Bell.—*Paper:* Engineering Operations for the Prevention of Malaria: F. D. Evans.

WEDNESDAY, JANUARY 27.

ROYAL SOCIETY OF ARTS, at 8.—Portrait Painting: the Technique of the Great Masters: Hon. John Collier.

THURSDAY, JANUARY 28.

ROYAL SOCIETY, at 4.30.—*Probable Papers:* The Influence of Salt-concentration on Hæmolysis: W. W. C. Topley.—The Life-cycle of Cladocera, with Remarks on the Physiology of Growth and Reproduction in Crustacea: G. Smith.—Investigations on Protozoa in relation to the Factor limiting Bacterial Activity in Soil: T. Goody.—On the Mesodermic Origin and the Fate of the so-called Mesectoderm in Petromyzon: S. Hatta.—The Influence of Direction of Homodromous and Heterodromous Electric Currents on Transmission of Excitation in Plant and Animal: Prof. J. C. Bose.

ROYAL INSTITUTION, at 3.—Modern Theories and Methods in Medicine—Immunity: H. G. Plimmer.

INSTITUTION OF ELECTRICAL ENGINEERS at 8.—The Sixth Kelvin Lecture. Lord Kelvin's Work on Gyrostatics: Prof. A. Gray.

FRIDAY, JANUARY 29.

ROYAL INSTITUTION, at 9.—Gaseous Explosions: Dr. Dugald Clerk.

SATURDAY, JANUARY 30.

ROYAL INSTITUTION, at 3.—Aerial Navigation—Scientific Principles: Dr. R. T. Glazebrook.

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